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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 169

TECHNICAL ARTICLES:

50,000 lb. Furniture Car, Chicago Burlington & Quincy R. R. (*with inset*)..... 170

Special Train for the Emperor of Austria (*illustrated*)..... 170

The Actual Resistance of Bearing Piles..... 171

Concrete Conduit in Tunnel of the Santa Ana Valley Irrigation Co., Orange County, Cal. (*illustrated*)..... 173

Standard Gage Engines for Broad Gage Track; Great Western Ry.... 173

Eight Years Travel over the Brooklyn Bridge (*illustrated*)..... 174

The Effect of Frost on the Sewage Filtration Beds at South Framingham, Mass..... 174

World's Columbian Exposition, III. (*illustrated*).... 175

How to Use a T-Rail for Street Railways (*illustrated*)..... 177

Petroleum Engines 177

Brown's Emergency Link M. C. B. Coupler (*illustrated*)..... 182

Sewage Purification in America (*illustrated*) 183

The Competitive Tests of the Westinghouse and New York Air Brakes on the New York Central R. R. (*illustrated*)..... 186

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS 177-179

EDITORIAL NOTES..... 180

The Competitive Tests of the Westinghouse and New York Brakes on the New York Central—The Collapse of the Reading Syndicate.

EDITORIAL:

The Use of Sewage for Irrigation in the West..... 180

LETTERS TO THE EDITOR..... 181

Continuous Rails—The Delano Rail Joint; C., B. & Q. R. R.—The Austin Dam Controversy—The Dunnings Dam—Salt on Brick Pavements—Radius of Gyration; Correction—Notes and Queries.

CONSTRUCTION NEWS.... 130-192

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The General Electric Co. has been granted a preliminary injunction against the Beacon Vacuum Pump & Electrical Co., stopping the manufacture of incandescent lamps by the latter company. The defense of the Beacon Co., alleging prior invention of the incandescent lamp by one Goebel (Eng. News, Feb. 2), was commented on as follows by Judge Colt, in his decision:

> It is easy, after an important invention has gone into public use, for persons to come forward with claims that they invented the same thing years before, and to endeavor to establish this by the recollection of witnesses as to events long past. Such evidence is to be received with great caution, and the presumption of novelty arising from the grant of the patent is not to be overcome except upon the most clear and convincing proof.

The matter will doubtless be carried to the higher courts. The granting of the preliminary injunction merely prevented the defendants from gaining advantage by the mere securing of delay.

The validity of the Berliner telephone patent, the issue of which was delayed for many years by the Bell Telephone Co. in order to continue their monopoly, is challenged by the government, and the Attorney-General has brought suit to have the patent annulled. The reasons why this should be done were explained in our issue of Nov. 28, 1891.

The City & South London Railway for the half year ending Dec. 31, 1892, shows receipts from all sources of $113,260, and operating expenses amounting to $76,945. The directors paid a 5% dividend on preference shares and ⅝ of 1% on the consolidated ordinary stocks, says the London "Railway News." The number of passengers carried, exclusive of season-ticket holders, was 3,217,602, an increase of 468,547 over the first half of the year.

The controversy over the awarding of the contract for dredging in Philadelphia harbor has been decided by Secretary Elkins by the rejecting of all the bids. This work was described in our issue of Jan. 19, and the bids received were published Feb. 9. The work will be re-advertised.

The pneumatic dispatch system of the Electric Pneumatic Transit Co. was tested at Philadelphia on Feb. 17. A double line of 6-in. pipe has been laid on Chestnut St. from the post-office building at Ninth St. to the sub-station between Third and Fourth Sts., a distance of 2,835 ft. Postmaster-General Wanamaker sent the first package over the line at 4:18 p. m., a Bible wrapped in an American flag. The pipe is ordinary wrought iron pipe bored smooth. The carriers used are of steel and carry about 15 lbs. weight. The air pressure used is 6 lbs. per sq. in. and the speed of transmission in the tests was 45 to 49 ft. per second (30½ to 34 miles per hour). The plant will be operated for a year by the company free of expense to the government; at the end of that time the government will have an option for the purchase of the system.

Insurance rates in Boston are to be advanced wherever electric wires run across the front of the building in such a manner as to impede the work of firemen. This is a result of careful study by the Board of Underwriters of the conditions under which the recent Federal St. fire occurred.

The trials of the dynamite-thrower, "Vesuvius," have clearly demonstrated the extreme accuracy of the weapon; the safety with which 200 lbs. or more of wet gun-cotton can be thrown from the gun, and the control of range. But so far an unexpected difficulty has been encountered in the failure of the fuses, used for firing the charge, on contact with the body aimed at. The Rapieff fuse, from which so much was expected, seems to have utterly failed, and the Board of Officers has for some time been experimenting with this and other firing devices in an attempt to discover what is the matter with this end of the test.

The Forestry Commission of New Hampshire has presented its second report and recommends that a permanent commission be established to investigate the character of the forests, the extent and different methods of cutting lumber, the revenue to the state, etc. They also suggest that this same commission inspect and report upon the public roads of the state. At the present time New Hampshire has not a line of legislation upon its statute books relating to the control or preservation of its forests.

The most serious railway accident of the week was a collision on the Pennsylvania R. R., at West Philadelphia, Feb. 22, in which 5 persons were killed and 12 injured. A local passenger train was passing over a switch to enter South St. station, when a fast express on the main track struck the last car just before it cleared the switch.

A head collision occurred on the Colorado Midland, about 20 miles from Leadville, on Feb. 18. The colliding trains were the Atlantic express and the westbound Utah express. One engineer, fireman and brakeman were killed, and 3 other trainmen were injured. The accident is said to have been due to one of the trains running ahead of its time to reach a meeting point.

Two locomotive boiler explosions are reported. One occurred on the Pittsburg, Cincinnati & St. Louis, at Norwich, O., Feb. 17. The locomotive was a freight engine in service. No one was injured. On Feb. 19 a Texas & Pacific freight locomotive exploded its boiler while working in the yards at Fort Worth, Tex. One man was killed and five injured. The boiler was a year and a half old, and carried 170 lbs. of steam. The explosion is laid to defective staybolts.

An electric car ran away on a steep grade at Portland, Ore., on Feb. 15, and was derailed at its foot, killing 3 passengers and injuring 25. A runaway on a cable incline occurred at Kansas City, Feb. 14, and 5 persons were injured.

New Orleans, La., is to spend $17,500, under the city engineer, in making a complete survey of the city with a view to establishing a general system of drainage. The "Picayune," of that place, wants this work done "by competition or otherwise," and under the "best scientific and professional advice." As the same journal says that the records of all previous surveys have disappeared from the City Hall archives, the work cut out for the city engineer seems eminently proper. The "scientific and professional advice" on a drainage scheme can come later, when there is some available data to figure upon.

The appropriation of $400,000 by Congress for the manufacture of magazine rifles for the army was based upon the recommendation of the Swedish Krag-Jorgensen model by the board of army officers who conducted the late tests. The Senate committee added the provision that no rifles shall be made under this appropriation until American inventors had a further 60-day trial of their weapons. This trial is now going on, and while an American gun is preferred, if no suitable arm is presented the Krag-Jorgensen model will stand as the adopted type. The Senate committee believes that an American magazine rifle can be found equal to or surpassing the Swedish arm.

The dredging of North Galveston, Tex., harbor has been commenced. The project includes the formation of a channel 60 ft. wide and 2 miles long, and requires the removal of about 8 ft. of sand and earth over this area, at a cost of about $100,000. The purpose is the creation of a deep-water channel to the point named and the opening up of a promising factory site.

The lumber output for the state of Michigan for 1892 is said to have been over 3,794 million feet B. M., besides the manufacturing of about 2,138 millions of shingles. The aggregate value of the lumber and shingles is placed at $66,000,000, and about 60,000 people are engaged in this industry, drawing $15,000,000 in wages. The three lumbering states of Michigan, Wisconsin and Minnesota, in 1892, produced over 8,934 million feet B. M., and about 4,249 millions of shingles. This is an excellent record for the timber-cutters; but how about the preservation of American forests and the welfare of future generations? One great purpose of a government Forestry Bureau is to look up these statistics, and to impress upon the people and their lawmakers that this timber supply is rapidly being exhausted. Foreign governments strictly regulate the output, and provide for coming needs by strictly enforced laws.

The Tehuantepec Railway, says the "Mexican Financier," is being pushed with more activity than ever before. There is now only a gap of about ten miles between the grading camps of the north and south divisions. Sand ballast is being supplied at the rate of 100 cars per day.

Wider streets for certain parts of Boston are recommended to the rapid transit committee of the legislature by the street commissioners, as a means of relieving congested travel in those districts. The plans prepared generally call for streets 80 ft. wide. The estimated cost of the proposed improvement, exclusive of paving and other items of construction, is $8,850,000. The betterments which could be collected are estimated at $2,000,000. The recommendation does not discuss the financial difficulties in the way of raising this sum of money.

A passenger steamer for the Fall River line on Long Island Sound is being built at the Roach shipyards, at Chester, Pa. This steamer is to be 440 ft. long over all, 52½ ft. beam, 93 ft. wide over the guards, 20½ ft. depth of hold, 12½ ft. draft and 4,550 tons displacement. Each of the double inclined engines will have cylinders 51 ins. and 95 ins. diameter, with 11 ft. stroke. The side wheels will be of the feathering type, 35 ft. in diameter and 14 ft. face. The vessel will be 20 ft. longer than the Fall River line steamer "Puritan," the largest boat now running on the Sound.

A substitute for the Nicaragua Canal bill is offered by Senator Stewart. It authorizes the President of the United States to contract with the governments of Nicaragua and Costa Rica for a right of way for an interoceanic ship canal between the Atlantic and Pacific oceans, on the route proposed by the Maritime Canal Co. of Nicaragua, and for a port at each end of the canal on the Atlantic and Pacific oceans; and to agree that the canal shall be constructed, equipped and put in operation within ten years. It also authorizes the President to negotiate with the canal company for the purchase of all its properties, rights and franchises; also to issue bonds not exceeding $100,000,000 in amount, and bearing interest at not over 3%, not over $8,000,000 of which is to be paid to the governments of Nicaragua and Costa Rica and the canal company. The Secretary of War, through the Engineer Corps of the Army, is to build, construct and equip the canal.

Two steel boats of the whaleback type are to be built in England for the American Steel Barge Co. One is to be a steamer and the other a tow-barge, with a combined carrying capacity of 9,000 tons. They will be used in the iron-ore trade between Cuba and Philadelphia, and are to be ready for their first trip in July next.

The locomotive which the Pennsylvania R. R. is building for its exhibit at the World's Columbian Exposition is said to be of the eight-wheel type, with four driving wheels 7 ft. diameter, four truck wheels 3 ft. 6 ins. diameter, and to weigh 135,000 lbs., with 80,000 lbs. on the drivers. The weight of the tender will be about 70,000 lbs.

The Corinth ship canal, 3.7 miles long, seems likely to prove a little Panama in its management and ultimate cost. In 1881 a French company began it with $6,000,000 capital, and work was commenced on March 27, 1882. The expenditure was so lavish and uncontrolled that the original capital was soon exhausted, and after some delay the bank of the Comptoir d'Escompte raised $2,800,000 more and the work went on. In March, 1889, this bank got into difficulties and the construction came to a standstill on July 31, 1889. A new company was formed, with a capital of $5,666,300, and the canal was taken in its unfinished state and a new contract was let on June 10, 1890. The contractor commenced work in September, 1890, and was to have the canal open to traffic on March 10, 1893, under a penalty of $20,000 per month for delay beyond that time. Owing to delay by floods an extension to May 10, 1893, was granted, and the contractor hopes to pass a large steamer through the canal on April 23 next. But the British Consul at Piraeus thinks this a very sanguine hope, and further says that the future can only decide how operating expenses and interest are to be paid on an ultimate cost of $13,750,000 under present contracts.

50,000-LB. FURNITURE CAR; CHICAGO, BURLINGTON & QUINCY R. R.

(With inset.)

The ordinary box cars for railway freight traffic are used for almost every variety of freight, but exceptionally large box cars are built specially for carrying large shipments of furniture, which is a bulky freight, from manufacturing cities to dealers in other cities. We illustrate this week the standard 40-ft. furniture car, 50,000 lbs. capacity, of the Chicago, Burlington & Quincy R. R., which has many interesting features, and for the drawings of which we are indebted to Mr. G. W. Rhodes, Superintendent of Motive Power. The general particulars of the car are as follows:

Length, over end sills	40	ft. 0	ins.
" inside	39	" 5½	"
Width, over side sills	9	" 0	"
" over body	9	" 1½	"
" inside	8	" 5½	"
" extreme, over roof at doors	9	" 9¼	"
Height, top of sill to bottom of side plate	8	" 7⅞	"
" floor to bottom of car line	8	" 9	"
" rail to edge of roof	12	ft. 6 7-16	"
" rail to top of brake staff	13	ft. 11¾	ins.
Wheel base, truck	5	" 0	in.
" total	35	" 0	"
Distance c. to c. of trucks	30	" 0	"
Weight, of body	18,400	lbs.	
" of two trucks	12,000	"	
" total	30,000	"	
Capacity	50,000	"	

The car is of unusual length, 34 ft. being the ordinary length for box cars, and 35 to 36 ft. for stock cars. In "Railway Car Construction," by W. Voss, it is correctly stated that for heavy loads 34 ft. seems to be the practical limit, as the supporting of the center portion of the car becomes difficult unless a third truck is employed, and this limit is usually followed for furniture cars, though their loads are rarely heavy. The "Car Builders' Dictionary" gives the general dimensions of furniture cars as follows: Length, 34 ft.; width over side sills, 9 ft. 4 ins.; height from top of sills to under side of plate, 7 ft. 6 ins. For the support of the center portion of the 40-ft. cars Mr. Rhodes uses four 1⅜-in. truss rods, with a truss depth of 18½ ins. below the sills. Box and stock cars are also built of similar construction to these furniture cars.

The body framing and general construction represent the latest example of practice in American freight car construction, and have been designed with regard to the teachings of experience in the maintenance and repair of other cars in service. The posts and braces are of white oak, 2½×4 ins., the posts being let into the sills and plates, and metal shoes or brace pockets are not used, except on the box and stock cars of the same class. At each post is a ¾-in. tie rod, passing through sills and plates. The posts are 3 ft. 6¾ ins. apart in the clear. The door posts are 5¾×4⅛ ins., and the end posts are 4×5¾ ins., in order to prevent bulging of the end of the car. The corner posts are 4½×3¾ ins., of white oak, let into the sills, and each corner post is tied back to the next side post by a ⅝-in. horizontal tie rod. The girths, also of white oak, are 2¼×2½ ins. The roof ribs are of Norway pine, with double roof boarding of 5½×⅞-in. boards, laid transversely and to break joints. The carlines are 1¾ ins. thick and 2 ft. 10⅝ ins. apart. The side plates are 7 ins. deep and 4 ins. wide, and the end plates are 3×13 ins., all of white oak. The running board is composed of three 1-in. planks, laid longitudinally. The floor is of 1¾-in. plank, tongued and grooved. The inner and outer sheathing is ¾ in. thick. The outer sheathing is of vertical strips, tongued and grooved. The inner sheathing is carried up to the under side of the plate, instead of merely to the girth, or belt rail, as in general practice, and is well nailed to posts and braces, thus making a good and complete job. The heights of maximum loading for wheat, corn and oats are painted on the inner sheathing. The end doors are 2 ft. wide and 4 ft. 1¾ ins. high.

The sills are 5×9 ins.; the side and intermediate sills of Norway pine, and the center sills of southern yellow pine. The end sills are of white oak, 7×10 ins. There are four truss rods, 1⅜ ins. diameter, upset to 1¾ ins. at the ends, where they are threaded for the turnbuckles and end nuts. They have a truss depth of 18½ ins. below the sills, and are 9 ft. 4 ins. long between truss rod bearings. The body bolster is of iron, and is of the pattern used for the company's standard stock, box and furniture cars of 60,000 and 50,000 lbs. capacity. The lower member is 1×8 ins., and the upper member ¾×8 ins., the latter being bent at the ends to form pockets for the side sills, as shown in the drawings. The center plate is of pressed steel, and the side bearings have inclined faces, with ⅝-in. clearance when the car is empty.

The draft rigging is between the center sills and attached to them, the drawbar passing through the end sill. This arrangement gives a direct transmission of buffing strains to the sills, and is infinitely superior to the common plan of attaching the draft rigging to draft timbers below the sills, as in the Illinois Central R. R. car illustrated in our issue of Nov. 17, 1892. With this latter arrangement all the strain comes upon the bolts holding these timbers to the sills, except in cases where filling pieces are used to make the draft timbers continuous, as in the standard coal car of the Chicago, Rock Island & Pacific Ry., illustrated and described in our issue of Aug. 11, 1892. The M. C. B. automatic coupler is used, with a rod for uncoupling from the outside of the car. A dead block or buffer block 4 ins. wide, and faced with iron, is at one side of the drawhead, and bolted to the end sill. By placing the draft rigging between the sills the car body sets very low, the floor being 3 ft. 4¾ ins., and the bottom of the sill 2 ft. 6 ins. above the rails. The cars are fitted with the Westinghouse automatic brake, with a brake shoe on the inner side of each wheel.

The trucks are the company's standard for 60,000-lb. box cars and 50,000-lb. furniture cars. They are of the diamond frame pattern, with rigid composite bolster, and spring hangers instead of the usual spring plank. There is a nest of four helical springs at each end of the bolster, with a steel spring hanger, 7×½ in. The bolster is 11¼ ins. wide and 9 ins. deep, but for cars of 60,000 lbs. capacity it is 9 ins. deep at the middle and 8 ins. at the ends, as shown by the drawings. It is composed of three oak beams (two 3×9-in. and one 4×9-in.), with two ½×9-in. steel plates between them, all bolted together with ⅝-in. through bolts. The transoms are 12-in. steel channels riveted to heavy solid end castings, and the spring hangers and brake hangers are riveted to the transoms. The diamond frame has an upper arch bar 1⅛×4 ins.; lower arch bar, 1×4 ins.; and pedestal tie bar ½ in.×4 ins. The wheels are of cast iron, 2 ft. 9 ins. diameter, placed 4 ft. 5⅜ ins. between backs of flanges (Eng. News, Feb. 2), and 5 ft c. to c. of axles. They are carried on collarless axles, 6 ft. 11 ins. long, with journals 4¼ ins. diameter and 8 ins. long, 6 ft. 3 ins. c. to c. The Illinois Central R. R. standard truck for freight cars of 60,000 lbs. capacity, was described and illustrated in our issue of Nov. 17, 1892.

SPECIAL TRAIN FOR THE EMPEROR OF AUSTRIA.

A complete train for the use of the Emperor of Austria has recently been built, and embodies many interesting features, some of which are based upon American practice. The train consists of eight cars, all connected by vestibules, which are exceptionally long, owing to the use of the European type of long spring buffers between the cars. Five of the cars are carried on four-wheel trucks, and three are six-wheel cars with rigid axles. The interior is arranged on the corridor plan, with the corridor along one side of the car, and the monitor roof is used in most cases. The train is lighted throughout with electricity, an engine and dynamo being mounted in one of the baggage cars. The Westinghouse and vacuum brakes are fitted, with two shoes to each wheel, and the brakes can also be operated by hand. The general particulars of the cars are given in the accompanying table, and the arrangement of the train is shown in Fig. 1:

Car No.		No. of axles.	Wgt. tons.	Lgt. over buffs.	No. of berths. Lw.	No. of berths. Up.	No. of lamps. 16 c.p.	No. of lamps. 10 c.p.
1.	Trainmen, baggage and dynamo.	4	45	56.0	2	—	1	14
2.	Attendants	3	19.2	39.1	6	6	3	7
3.	Emperor's car	4	32.3	56.0	—	—	13	11
4.	Saloon car for suite	4	34.3	56.0	6	—	9	6
5.	Dining car	4	33.0	56.0	—	—	18	1
6.	Kitchen car	4	33.0	56.0	2	2	9	6
7.	Car for suite	3	19.8	39.1	7	7	10	5
8.	Servants and bag'e.	3	18.5	39.1	6	6	4	6

1. The service, baggage and lighting car contains at the front end a room with desk and lookout for the conductor. Adjoining is the engine room, furnished with boiler, steam engine and dynamo, particulars of which are given below. Then follows the baggage room and the coupe for the director of travels, fitted with desk, washstand, etc. The windows of this room project somewhat on each side, and are provided with mirrors, so that the whole train may be observed.

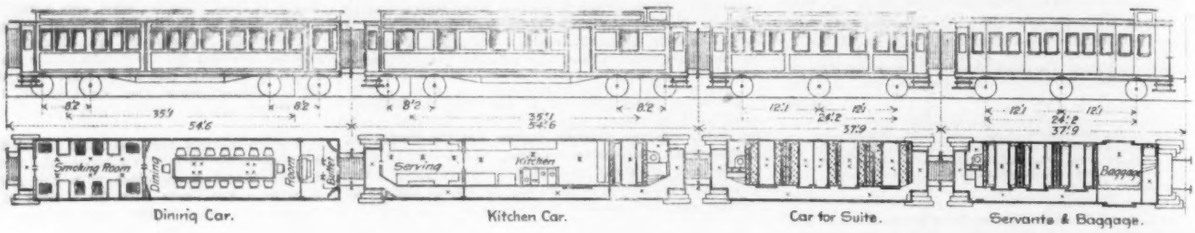


FIG. 1. ELEVATION AND PLAN OF TRAIN

2. This car contains one first class and two second class compartments. The first has silk head lining, walls lined with olive-colored cloth and seats upholstered in moquette. The others have the walls lined with patterned wax cloth; the seats are covered with dark green leather, and may be used as berths by raising the hinged backs into a horizontal position. This arrangement seems to be in general adoption throughout the train.

3. The emperor's car contains at the front end the room for the body servant upholstered in drab. Adjoining this is the bedroom of the emperor, furnished with an iron camp bedstead, washstand with silver tipping basin, two folding tables and several chairs. The walls have a covering of olive-covered silk, with cloth frieze of the same color. The ceiling is finished in light drab silk, with carved and inlaid moldings. The chairs have an olive-colored cloth covering. A door leads from the bedroom to the saloon, the upholstering of which is similar to that of the bedroom. The general arrangement of the furniture which the saloon contains can be seen from the plan of the car (Fig. 1). Next the saloon is the compartment for the emperor's aide-de-camp, divided by a partition with sliding doors, and furnished in a similar manner to the saloon. Its smaller division, or bedroom, is furnished with a lounge and chair; the dressing room is separated from it by a curtain, and is paneled in walnut.

4. The saloon car for the emperor's suite has separate compartments opening into the corridor, and at the rear end of the corridor are steps leading to a lookout for the brakeman. The closets at

each end are paneled. The two half compartments near the front end of the car can be transformed into a small parlor by opening the sliding door between. Each contains a washstand which can be covered by a hinged top, a lounge with moquette covering and reversible mattress, and a mirror with small table. The furniture of the main saloon is upholstered in olive-colored cloth, with Japanese wall paper and carved moldings. The two full compartments are finished in a similar manner to the half compartments. In Fig. 2 is shown a part side elevation, with longitudinal section through one compartment of this car.

5. In the dining car are three main compartments, smoking room, dining room and buffet. The smoking room is furnished with four card tables and two seats each. The walls are lined with leahter hangings and the head lining is of silk. The seats are covered with brown plush. The dining room is reached by a double sliding door. Its walls are lined with hand-carved and bronzed leather hangings, framed and carved in wooden friezes. The ceiling is ornamented with three oil paintings, framed in carved walnut. Against the partition opposite the smoking room stands a tall pier glass, with a sliding door at each side opening into the buffet. The dining table is made up of three separate extension tables. The covering of the chairs is stamped leather. The walls of the buffet are paneled, and the ceiling is covered with silk. This compartment contains two corner closets and a large extension serving table.

6. The kitchen car consists of the serving room, the kitchen proper and the compartment for the chef, with a corridor connecting the two platforms. The serving room is finished in light colored pine. All mountings are of nickel bronze. Along the sides are arranged the cases for dishes, which can be covered by hinged lids. In one corner is placed the ice-bok. The kitchen proper contains two cases for dishes, the cover of one of which is used for washing dishes; a hinged table, two ice boxes, a range with coal box and a large case for storing away the mattresses for the waiters. The chef's compartment, adjoining the kitchen, has two berths of the pattern already described.

7. The first-class car for the emperor's suite contains two full and three half compartments, with seven berths in all. Fig. 3 is a transverse section through one of the compartments.

8. In the car for servants and baggage are three full compartments, with two berths each, the baggage room with sliding doors at sides, and a lookout with seat for the rear brakeman.

Fig. 2. Part Elevation and Section of Car of Emperor's Suite.

The electric lighting plant is installed in car No. 1, a cross-section of which is given in Fig. 4. The current is generated by a dynamo driven by a two-cylinder engine, with boiler. The current is conducted by two cables, with flexible connections between the cars. Each car is provided with a storage battery of 30 cells each, which will begin to act automatically in case of accident, and is capable of supplying the electric lights for ten hours. The truck frames and underframes of all the cars are constructed of iron, and all the cars have plate springs. The trucks have also elliptic springs at each end of the bolster and spring plank. The wheels are of wrought iron with double spokes and hubs; the axles and tires are made of Krupp crucible steel. The diameter of the wheels is 3.29 ft. The axle boxes, Fig. 5, are of cast iron, with brasses and white metal bushing. The oil is applied to a suction wick from above and to a pad of waste below the latter, held up to the journal by springs.

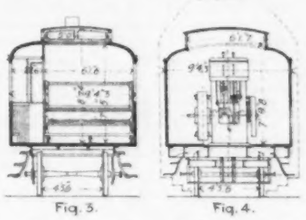


Fig. 3. Through Car Saloon.

Fig. 4. Through Dynamo Compartment.

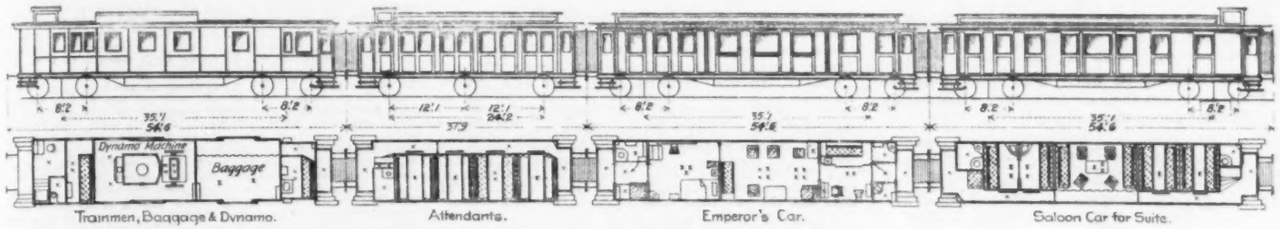
CROSS-SECTIONS.

All cars are constructed to pass curves of 507 ft. radius easily. The cross-sections are of such dimensions that the train can be run on all standard gage railway lines of the continent. The coupling of the cars is effected by the standard Austrian type of couplers.

The body of the car is about 9 ft. 3 ins. wide over all, and is built throughout of oak, with the exception of the roof framing, for which pitch pine is used. The outer sheathing of the sides is oxidized and polished sheet iron. The spaces between the double boarding of sides and roof are filled with saturated paper. The spaces between the three courses of flooring are filled with cork for the purpose of deadening sound. The roof covering of the upper decks is of tinned sheet iron roofing, and for the lower deck copper plate is used. All cars, except car No. 1, have an extra upper deck roof covering of fire proof canvas, painted white. The floors of the principal rooms are lined with lead plate, 3-32 in. thick, above which is spread a layer of felt and cork cloth. The sides have also an extra lining of heavy felt. The cars are painted olive green with light striping; the outer window casings and moldings are gilded.

The cars are heated by steam, and the temperature can be regulated by valves, with which each radiator is equipped. Besides the ventilators of the monitor roof, air openings are provided for in the floor under the radiators, the fresh air entering having to pass the latter before being admitted into the interior of the cars. Cars Nos. 3, 4 and 5 are equipped with separate telegraph connection. The locomotive has a speaking tube connection with car No. 1. Of interior signals two types are in use, the Raye signal and the Prudhomme signal.

The train is provided with hand, vacuum and Westinghouse brakes. The cars of this train were built at the works of F. Ringhoffer, Smichau, near Prague, Bohemia.



OF THE EMPEROR OF AUSTRIA.

THE ACTUAL RESISTANCE OF BEARING PILES.

The following gives a summary of 17 different records of the actual bearing power of piles, as collected by Mr. John C. Trautwine, Jr., for his discussion of Mr. Foster Crowell's paper on "Uniform Practice in Pile Driving" (Eng. News, Oct. 27, 1892, Trans. Am. Soc. C. E., August, 1892). It is doubtless one of the most complete records of such data in existence, albeit in many cases, not to say most cases, the data are open to more or less suspicion as to their accuracy.

We give the statement of conditions in each case in Mr. Trautwine's own words, omitting his reference to authorities, which can be found if desired in the original paper. Below each of these statements we give the safe load indicated by the so-called "Engineering News" formula, viz.:

$$\text{Safe load} = \frac{2\,wh}{s \times 1}$$

in which w = weight of hammer by any unit (the load given being in the same unit) and h = its fall in feet; s = set under last blow in inches.

Mr. Trautwine himself gave a tabular comparison of the ultimate loads given by three different formulas when applied to these records, viz.: 1. The Engineering News formula. 2. The same in the modified and more complex form proposed by Mr. Foster Crowell. 3. The Trautwine formula. We do not summarize this comparison, first, because it clearly shows that the Engineering News formula gives the closest approximation of the three, and secondly, because the Engineering News formula for ultimate load (= six times the safe load) is not intended to be used for determining ultimate loads, and not alleged to give them with any accuracy, for the reason that the ultimate load is a much more variable quantity than the permanent safe load. At least we so understand it; and certainly the safe load is the only thing we are aiming to determine or care to know. If, therefore, formulas are to be compared, the only proper way is to include the effect of their proposed factors of safety, which, for the Trautwine formula, are 1-12 to 1-2.

To show the effect of doing so we may instance seven cases of known loads and facts as to driving which are given in Trautwine's "Pocket-Book," and are an addition to the following list. It should be borne in mind that in some, if not all of the following instances of piles under foundations, the surrounding soil bears an unknown proportion of the load, so that the load actually coming on the piles may be several times less than stated.

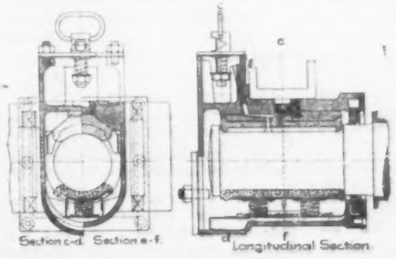


Fig. 5. Axle-box Used on Cars of Imperial Train.

Instances of Bearing Power of Piles given in Trautwine's Pocket Book.

Locality and soil.	Hammer, fall and set.	Actual load.	Safe load by Eng. News.	Safe load by Trautwine's formula.
Chestnut st. Br. Mud.	1,200 lbs., 40 ft. 34 in.	40,300	29,100	8,070 to 18,000
Neuilly Bridge. Gravel.	2,000 lbs., 5 ft 0.016 in.	105,300	19,700	14,500 to 87,000
Hull docks..... Mud.	1,500 lbs., 24 ft. 2 in.	45,000 to 56,000	24,000	6,180 to 37,100
Royal Border Bridge..... Sand and gr.	1,700 lbs., 16 ft. 0.05 in.	156,800	53,700	17,380 to 105,300
Phila. expts.... Soft mud.	1,000 lbs., 36 ft 18 in.	14,500 to 20,120	6,060	1,194 to 7,155
U. S. test pile.. Silt and clay.	810 lbs., 5 ft. 0.375 in.	50,000	6,000	4,858 to 29,150
French rule .	1,344 lbs., 4 ft. No set.	56,000	10,742	6,575 to 39,450

It will be seen that the last column gives extremely vague indications as to the real bearing power. Of what use would be a formula which

simply told a man that the proper cost of a structure was from $8,000 to $48,000, while the utmost it could cost without breaking the company ought to be about $96,000, but might be a good deal more or less? That is what the last column of the above table says in effect, with the further evil feature that it encourages a man to believe that he may spend up to $48,000 and still have a "factor of safety of two," when the fact is he cannot do anything of the kind.

No formula can attempt to state exactly how much should be spent in such a case, or how much load can safely be placed on the pile. What the Engineering News formula does purport to do is to set a definite limit, high enough for all ordinary economic requirements, up to which there is no records of pile failures, excepting one or two dubious cases, where a hidden stratum of bad material lay beneath the pile, and above which there are instances of both excess and failure, with an increasing proportion of failures as the limit is exceeded.

If it does this, as it is believed to do, it is in all cases a safe guide, having the risk of semi-fluid material existing beneath the foot of the pile; and in most cases a sufficient guide as well. But when a large number of piles are to be driven or extra heavy loads are to be sustained, ordinary prudence would dictate the ascertaining by experiment just what the piles will bear, or, if failure would do no great harm, taking chances with greater loads without experiment, under favorable conditions. The formula is not intended to be rigidly applied to such cases as this.

The valuable records below given, in comparison with the safe load by the Engineering News formula for safe load, may be abstracted as follows; and they seem to be fairly good proof that the Engineering News formula is, in fact, trustworthy to the extent above claimed for it:

Summary of Instances of Bearing Power of Piles given in more Detail below.

Case No.	Actual ultimate load.	Safe load by formula.	Factor of safety.	Material.
1	13,333	1,684	7.9	Mud.
2	14,560	6,067	2.4	"
3	22,400	23,450	—1.0	"
4	44,800	28,333	1.6	"
5	to 15,175 to 47,375	11,400	to 1.3 to 4.1	Alluv.
6	59,618	6,741	8.8	Mixed.
7	75,000	44,080	1.7	Sand.
8	224,000	112,000	2.0	.....
9	13,140	to 8,020 to 9,520	1.7 1.4	Sandy. Mud.
10	to 6,400+ to 13,333+	to 10,183 to 20,000	Not determinable.	Sandy. Mud.
11	to 6,400 ~ 13,333+	to 10,667 to 11,790	" "	" "
12	over 22,400+	37,500	"	"

Tests of Piles in which the Resistance to Extraction is the Only Evidence as to Ultimate Bearing Power.

13	to 490 to 1,288	to 108 to 251	....	Sandy. Clay.
14	15,850	25,067	....	Unknown.
15	to 25,000 50,000	5,000 5,000	....	Rotten rock.
16	to 50,000 83,000	to 51,250 to 88,000	....	Sand. "
17	to 71,300 71,300	to 12,800 to 17,920	....	Clay. "

Case 1.—Pile trestle at Aquia Creek, Va., 1871. Creek bottom, almost fluid mud over 80 ft. deep. Tide water 6 ft. deep. Trestle bents of six piles each, 12½ ft. between centers and about 15 ft. high. Piles 15 to 18 ins. diameter at butt, 50 to 56 ft. long, cut off just above low water-mark.

(The records show a 2,000-lb. hammer, falling 4 ft. with 8.5 ins. set or 9.7 ft. with 22 ins. set. Safe load by formula, 1,684 and 1,682 lbs. (but in reality the safe load in this case would have been computed under the data of Cases 10 and 11 below, which see). (Actual load 13,333 lbs. Continued actual safe load, 6,400 lbs.).

Case 2.—Philadelphia, 1873. (Soft river mud. Trial pile loaded with 14,560 lbs. five hours after driving, and sank but a very small fraction of an inch. Under 20,160 lbs. it sank ¾ in.; under 33,600 lbs., 5 ft.

(The records show 1,600 lb. hammer falling 36 ft. with 18 ins penetration. Safe load by formula 6,067 lbs.

Case 3.—Mississippi River at East St. Louis, 1868-69; soft muddy bottom, with 5 or 6 ft. of water. Piles in temporary railway trestle of three-pile bent, 15 ft. from center to center, driven about 20 ft. Penetration 2⅛ to 3 ins. The piles settled badly in a very short time under locomotives weighing not over 30 tons, so that the load on a pile could hardly have exceeded 22,400 lbs.

(Safe load by formula taking 27½ ft. mean fall, 2¾ ins. mean penetration, 1,600 lb. hammer; 23,450 lbs. Many of the data of this case are quite dubious, especially the weight given for locomotives. There were very few, if any, in Missouri in 1868-9 so light as 30 tons. It is more likely the load in each pile was double that stated.)

Case 4.—Perth Amboy, 1873; "pretty fair mud," 30 ft. deep. Four piles, 12, 14, 15 and 18 in. diameter at top, 6 to 8 ins. at foot, were driven in a square to depths of from 33 to 35 ft. Distance apart not given. A platform was built upon the heads of the piles and loaded with 179,200 lbs., say, 44,800 lbs. per pile. After a few days the load was removed. The 18-in. pile had not moved; the 12-in. pile had settled 3 ins., and the 14 and 15 in. piles had settled to a less extent.

(Hammer 1,700 lbs. falling 25 ft. with 2 in. penetration; whether the same for all the piles or not is not stated, indicating that the record is somewhat lacking in precision. Safe load by formula, 28,333 lbs.)

Case 5.—Fort Delaware, 1850. The account is highly unintelligible. Material, an alluvial deposit. The piles were of Chesapeake yellow pine weighing from 32 to 59 lbs per cu. ft. They measured 12 ins. square, and were about 30 ft. long, with points 5 ft long. Four trial piles were driven about 24 ft. (distance apart not stated) and capped with a platform upon which the loads were placed. The weight of ram is variously given at from 1,883 to 2,000 lbs. It appears to have been about 1,900 lbs.

(Safe loads by formula, calling fall 6 ft. and set 1 in. = 11,400 lbs., which checks quite accurately, as the piles settled 3-16 in. under 15,175 lbs. By gradual increments of loads extending up to 47,375 lbs., however, they only settled 1 in. in all, at the end of a period of 10 years. At the end of 5 years, with nearly 40,000 lbs. load, they had settled just ½ in..).

Case 6.—Proctorsville, La. Material, mud, sand and clay; wet. Trial pile (driven alone) said to have been 30 ft. long, yet it is said to have sunk 5 ft. 4 ins. by its own weight, and to have been driven 20 ft. 6 ins. deeper, making 34 ft. 10 ins. driven length. Cross-section, 12½ × 12 ins. at top, 11½ × 11 ins. sharpened to 4 ins. square at foot. Weight, 1,611 lbs. Head capped. Pile bore 59,618 lbs. without settlement, but settled slowly under 62,500 lbs. Fall, during last ten blows, regulated to 5 ft. exactly. Penetration, last ten blows, ranged from ¼ to ½ in.; mean 0.35 in.; last blow, ⅜ in.

(Hammer 910 lbs. safe load, by formula, 6,741 lbs., being very far below what the pile actually sustained. This is another case of those piles in soft material whose resistance is not fairly measured by the blows given when first driving, but can only be fairly gaged by trying blows after the mud has had time to set.)

Case 7.—Buffalo. Material, wet sand and gravel. Piles driven in nests of from 9 to 13 piles. Test pile of beech., 20 ft. long after being driven and cut off. Driven length, 20 ft., 3 ft. in stiff clay; cross-section, 15 ins. diameter at top. A load of 50,000 lbs. remained on the pile for 27 hours, but produced no appreciable effect. The load was increased 20,000 lbs. at a time, and left for 24 hours after each increase. A gradual settlement aggregating ⅝ in. took place under 75,000 lbs., and the pile then came to rest. The total settlement increased to 1½ ins. under 100,000 lbs., and to 3 1-16 ins. under 150,000 lbs. During the experiments the ground was kept in a tremor by the action of three pile-drivers at work on the foundations. Subsequent use shows that 74,000 lbs. is a safe load.

(Hammer, 1,900 lbs.; fall 29 ft.; set, 1.5 ins. Safe load by formula, 44,080 lbs. As a "gradual settlement aggregating ⅝ in., took place under 75,000 lbs.," this 44,080 lbs. is as large a "safe load" as the circumstances warranted, unless some settlement was not objected to.)

Case 8.—Brooklyn, N. Y., 1847-48. Dry Dock at Navy Yard. Material, wet, loamy, micaceous, quartz sand, becoming quicksand wherever it was much trodden.

"The main piles were mainly round spruce bars, very straight, from 25 to 45 ft. long, averaging a driven length of 32 ft." "They were not less than 7 ins. in diameter at the smaller end, and 12 to 18 ins. (on an average, 14 ins.) in diameter at the larger end. The trial piles averaged 12 ins. in diameter in the middle. The heads of the piles were protected." The piles "were driven in rows 2½ ft. apart, and at transverse distances of 3 ft., all from center to center." But "intermediate piles, of very tough second growth oak, were frequently driven." "The piling machines were strongly and accurately made, with the ways bound with smooth plates of iron." They gave about one blow per minute. A Nasmyth hammer was used also, and gave 60 blows per minute. I have assumed that some of the piles tested were driven by it, although this is not stated in the reports. The author applies the test to a penetration of 0, but "the average distance driven by the last five blows was 1 in." We therefore take the experiments as embracing $s = 0$, and $s = 0.2$.

As the result of the tests it was believed that for a pile driven 33 ft. into the earth to the point of ultimate resistance with a ram weighing 2,240 lbs. and falling 30 ft. at the last blow, the extreme supporting power due to the frictional surface was 224,000 lbs., or 1 ton per superficial foot of the area of its circumference.

This case illustrates the criticism already made of Mr. Crowell's formula that, like Major Sanders', it gives excessive loads where the penetration is very small. For the ordinary machine, our formula here gives better results than Mr. Wellington's, but for the Nasmyth machine, which I have assumed to have been used on the piles tested, his results are almost exact, while ours are double the actual load.

(Safe load by formula, for 0.0 to 0.2 penetration, 134,000 to 112,000 lbs., or about half the estimated extreme supporting power. As there could hardly be a "better result" than this, the statement that the Trautwine formula gives "better results," is very incorrect in fact, and is based only on a comparison of ultimate loads, which for 0.2 penetration Trautwine has as 290,000, instead of $6 \times 112{,}000 = 672{,}000$ ultimate by the Engineering News formula.)

Case 9.—Dordrecht, Holland, 1872. Bridge over the Maas; temporary piles under staging. The author informs us that "the staging sank fully ¾ in., and during their erection the girders had constantly to be wedged up"; but leaves it to the ingenuity of the reader to deduce the other data required for our present purpose. The material seems to have been sand, with some mud; average depth of water, 19 ft.; maximum, 23 ft. The piles seem to have been driven either by a steam pile-driver delivering 60 blows per minute with a ram of 2,205 lbs., falling 30 ins., or by "an ordinary hand engine"; ram, 992 lbs.; fall, 6 ft. 7 ins. Both cases are given in the table. However this may be, we are told that "some of them went in much too easily, being driven ¾ in. and 1⅛ in. with the last blows." But "it was arranged, where the penetration was more than ¾ in. on the average of the last 100 blows, to put in" additional piles. I therefore take ¾ in. as the probable penetration. The load seems to have been about 13,440 lbs. per pile.

(Safe load for 2,205-lb. hammer, 8,020 lbs.; with 992-lb. hammer, 9,520 lbs. As the piles sank continuously but not hopelessly under 13,440 lbs., these loads check as well as could be desired.)

Case 10.—Aquia Creek. See Case 1. A pile 40 ft. long, after sinking some 30 ft. with its own weight and that of a 2,000-lb. hammer, was given a blow of 2-ft. fall, after which it sank 6½ ins. further in one minute under its own weight and that of the hammer, and then stopped. Four weeks later a 5-ft. blow failed to move it, and a blow of 14 ft. drove it only 4½ ins. This case and the following one illustrate strikingly the effect of time in increasing the stability of a driven pile. In both cases the blow recorded was delivered four weeks after the settlement under the load. A load applied after the blow, as usual, would undoubtedly have made a better showing for the formulas.

(Safe load by formula after 5 ft. blow with no penetration, 20,000 lbs.; after 14-ft. blow with 4½-in. penetration, 10,183 lbs.; actual load carried without failure, 6,000 to 13,000 lbs.)

Case 11.—See Case 1. A pile 43 ft. long received two blows of 2 ft. each, and then settled under 2,000-lb. hammer 1½ ins. in two minutes. Four weeks later it penetrated 2¾ ins. under a 10-ft. fall, and 8½ ins. under a 28-ft. fall.

(Safe load by formula, 10,667 and 11,790 lbs., respectively; closely corresponding with actual loads safely sustained.)

Case 12.—Lake Ponchartrain Trestle, La. About 6 miles of trestle crossed the lake proper, and the remainder (16 miles) crossed the adjoining sea-swamp. Four-pile bents, 15 ft. between centers. Material of swamp, several feet of soft, black vegetable mold, lying upon soft clay, with occasional strata 1 to 2 ft. thick, of sand. Piles sank from 5 to 8 ft. of their own weight, and then about as much more with hammer (about 2,500 lbs.) resting on head of pile. Two piles 65 ft. long were driven, one on top of the other, and penetrated 9 ins. with over 100 ft. driven; but a 30-ft. fall, 30 minutes after driving a pile, gave only 3 ins. penetration. Piles 65 to 75 ft. long. Weight of ram about 2,500 lbs. Fall, about 30 ft. Penetration, 3 to 12 ins. I have taken $s = 3$, 6, 9 and 12. "No settlement has been observed in the entire length of the structure to date." As there were four piles in a bent, and the bents were 15 ft. apart, the load on each pile probably has not exceeded 22,400 lbs. Although the extreme load is not given, we include this case as forming an interesting contrast with Case 3, also given by Mr. Bouscaren.

(Safe loads for 3, 6, 9 and 12 ins. penetration, 37,500, 21,430, 15,000, 11,538 lbs. As the only proper fall to be considered in a case like this is the 3-in. penetration, which occurred after 30 minutes' intermission, the check here is excellent.)

Case 13.—Small experimental piles. "Resistance of Piles to be Ice-drawn," by J. W. James. Material of various kinds, chiefly compact sandy clay, compact gravelly clay, with surface soil, sometimes wet, sometimes dry. The "piles" were small sticks of oak, as follow: Square, 1 to 2 ins. side; cylindrical, 1 to 2 ins. diameter; flat, 3¼ × 1 in. They had points of different shapes. A large number of experiments are recorded, of which the means given in the table are fairly representative.

Mr. Crowell's formula is hardly applicable to a case like this, for we have no way of finding his n, which is $\frac{1}{4 s'}$, where s' is the penetration as it would be under a blow of a 2,000-lb. ram falling 20 ft. or other equivalent (?) blow of 40,000 foot-pounds. Since none of the loads reach 2,000 lbs., it is plain that the mere weight of a 2,000-lb. ram would have driven the pile indefinitely, and we can hardly doubt that any blow of 40,000 foot-pounds would have done the same, and would also have abruptly terminated the experiment.

(These curious records are of value only as checking the generality of a pile-driving formula, but in that way check extremely well, as follows:

Wt. ram, lbs.....	22.8	21.9	23.8	32.2	23.1	39 0
Ht. fall, ft.....	4.6	7.6	7 2	7.2	7.3	6.8
Set., ins.....	.94	.89	.36	.45	67	.76
Safe ld. by formula.	108	200	251	231	203	301
Observed resistance.	490	572	1,288	822	742	959
Ratio, 1 to.....	4.5	2 9	5.1	3.5	3.6	3.2

When it is remembered that the "observed resistance" is merely that to pulling, the formula for safe load could hardly check better with the actual observations.)

Case 14.—Ice-drawn pile. Observations made January, February, March, 1873. From the paper quoted in case 13. Material not stated. Pile about 12 ins. diameter, under a bridge constructed during the previous year across a river confined by a mill-dam. The fall was approximately 20 ft. "The driver (940-lb. hammer) was worked on the ice, and equal lengths of the piles did not project above its surface when the last blow was delivered." The penetration is said to have been ⅛ in. The load was estimated by the uplifting force of ice. "The piles held their ground, and the ice broke away, until it had attained a thickness of 15 to 16 ins., when the piles began to come up." The lifting force was estimated, from experiments by the author upon small, smooth sticks, at 18,850 lbs. per pile. Deducting weight of superstructure, about 3,000 lbs., leaves 15,850 lbs. as the estimated force required to draw the pile.

In view of the smallness of the actual load in this case, it may reasonably be asked whether much of the energy of the blows was not consumed in overcoming the friction of the piles against the ice through which they were driven. It will also be noticed that the force was an up-lifting one, and that its amount was esti-

mated by means of the adhesion of ice, as derived from experiments with small, smooth sticks. The weight of ram, height of fall and penetration, were all taken by the author of the paper at hearsay, from a man who had worked on the bridge. The case is, in fact, one of exceptional doubtfulness in all respects.

(Safe load by formula, 25,067 lbs.; agreeing sufficiently well with probabilities.)

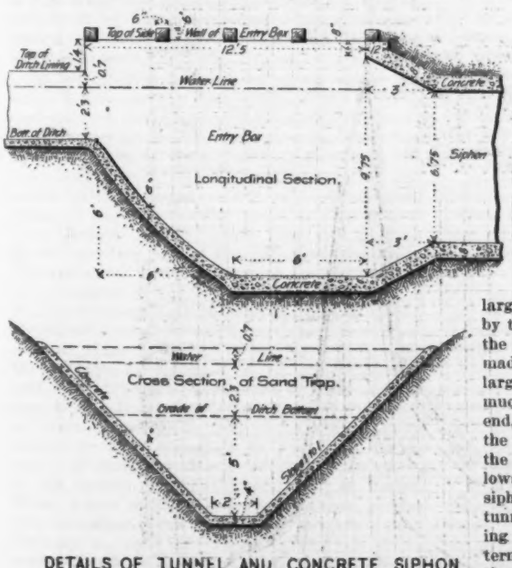
Case 15.—Proposed Cambria Reservoir, Philadelphia, 1883. Notes by the writer. Material, wet, decomposed mica schist. A wrought iron pipe, 3½ ins. outside diameter, 3 ins. inside, was inserted in a bore-hole 6 ins. in diameter and 30 ft. deep, and driven 14 ft. to rock. The lower end of the pipe was dressed to an annular cutting edge. Load.—After several hours' work with block-and-fall, the pipe was pulled in two by using two hydraulic jacks of unequal power, one on each side, by means of which the pipe had been raised 8 ins. The fracture took place in the thread, where the wall thickness was reduced from ¼ to ⅛ in., leaving a cross-sectional wall area of $3\frac{1}{8} \times 3.1416 \times \frac{1}{4} = 1.23$ sq. ins. Since the pipe had risen slightly under the pull which soon after caused its rupture, the latter was evidently about equal to the resistance of the pipe to being withdrawn. We can estimate at the amount of this pull by estimating the tensile strength of the iron at the point of rupture. The conditions of the experiment were very crude, but considering that the pipe was no doubt weakened by canting from side to side under the unequal forces exerted by the two jacks, as well as by repeated blows in driving, and repeated tensile strains in drawing, and by the removal of the outer "shell" of the iron in cutting the thread, the tensile strength could hardly have exceeded 40,000 lbs. per sq. in., and, on the other hand, it was perhaps not less than 20,000, giving 25,000 to 50,000 lbs. as the extreme load.

(Hammer of 350 lbs. falling 8 ft., set ⅛ in., sustained 25,000 to 50,000 lbs. Safe load by formula, 5,000 lbs. scant.)

Case 16.—Pensacola, Fla. Material, clean, hard, sharp, white quartz sand. All the sand would pass through a sieve having openings 1-12 in. square. Water filtered through it came out perfectly clear. One cu. ft. of it would hold 6 qts. of water. The 2-ton hammers could only drive about 20 ft. The water was about 11½ ft. deep. Seven piles, selected as representing the average of all, were tested with upward pulls of 20,000 lbs. each without moving, and one of these was afterward tested with upward pulls sufficient to cause motion (as recorded below) and finally withdrawn. This pile was 29 ft. long, 16 ft. in sand, including its point, 2 ft. long. One foot of this length was in loose sand, which had been excavated and had fallen back. The average diameter of the part in the sand was 13½ ins., including the bark. Weight of pile, 1,632 lbs. Pile tested two months after it was driven. Neither weight nor fall of hammer nor set given.

The following guesses at their values are the result of laborious study of their remarks respecting the foundation piles as a whole, and are to be taken as of very doubtful correctness:

				(Safe load, by formula.)
1st.	w = 2,200,	h = 30,	s = 0.5.	(88,000)
2d.	w = 4,100,	h = 33,	s = 0.0.	(270,000)
3d.	w = 4,100,	h = 10,	s = 0.6.	(51,250)



DETAILS OF TUNNEL AND CONCRETE SIPHON AND SAND TRAP OF THE SANTA ANA VALLEY IRRIGATION CO.

The tests on the trial pile resulted as follows:

78,000	lbs.	...No movement.
80,000	"	...Resisted ¼ min., and then rose very slowly. Rose 2½ ins. in 30 min.
82,000	"	...1½ min.
83,000	"	...½ min. Rose 2½ ins. in all, in 30 min.
60,000	"	...18 hours. No movement.
64,000	"	} Rose 3 ins. in one hour, 6 ins. in all.
74,000	"	
50,000	"	...For two days. No movement.

The very small loads obtained by the test in this case seem to confirm the view already expressed that the resistance of a pile to an upward pull must be less than that to a downward pressure. This is especially noticeable in comparison with the Brooklyn tests, Case 8, where the conditions were nearly similar, but where the pile (tested by pressure) bore much greater loads. The sand at Pensacola was remarkably pure, and hence could probably exert little resistance to being broken up, while offering great resistance in the opposite direction, as is shown by Mr. Towle's statement that at a depth of 15 ft. a 2-ton ram (falling 33 ft.) rebounded nearly a foot.

(The safe loads by formula, as interpolated above, check very accurately with the probabilities indicated by the test.)

Case 17.—Albert Dock, Hull, England. Removal in January and February, 1880, of coffer-dam built in 1874. Material, compact bluish clay, above which there were from 3 to 5 ft. of peat, and above this silt and sand in places. Piles of ordinary rough Memel bark timber, from 10 × 12 to 14 × 15 ins. Average, 12½ ins. square. From 30 to 40 ft. long. Driven length, from 6 to 30 ft.; average, 18¼ ft. Most of the piles were driven from 10 to 20 ft. into the clay and were nearly or quite in that material alone; but a few of the shorter piles, driven in a sloping side of the dock, were entirely in the silt, while a few others entered the peat without reaching the clay. The piles were driven close together in two rows 5 ft. apart, forming a coffer-dam, the space between the two rows having been filled with puddled clay "to above high water mark." Before the piles were withdrawn the puddle was removed down to a level "rather under high water-mark of ordinary neap tides."

The height of fall (2,240-lb. ram) varied from 5 to 6 ft., and the penetration from 0.5 to 0.75 in. I have taken the extreme cases; 420 piles were withdrawn and 300 observations recorded. The force was applied by men working a winch and estimated by testing that of the men in lifting known weights. The piles were drawn consecutively, so that one side of each pile was nearly or quite free from frictional contact, the opposite one was in loose contact with the adjoining pile, and only the remaining two sides resisted by friction with the ground.

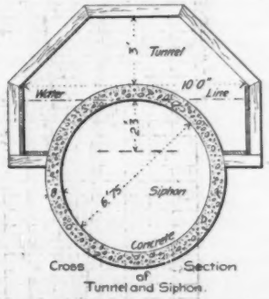
The average total force required to draw a pile was 75,869 lbs. The author deducts from this 2,340 lbs. (= 12 × 12 ins. × 15 lbs. per sq. in.) for suction, and 2,240 lbs. for weight of pile, leaving, say, 71,300 lbs. as the frictional resistance to drawing the pile.

(Safe load by formula, with ¾-in. set after 5 ft. fall, 12,800 lbs.; with ½-in. set after 6 ft. fall, 17,920 lbs.)

CONCRETE CONDUIT IN TUNNEL OF THE SANTA ANA VALLEY IRRIGATION CO., ORANGE COUNTY, CAL.

By H. C. Kellogg, Engineer.

This conduit supplements and is placed in the bottom of a tunnel lined with timber. Its dimensions are: Length, 700 ft.; net inside diameter, 6¾ ft.; thickness of shell, 8 ins. It was constructed in the form of an inverted siphon in order that it shall not raise the hydraulic grade line of the canal (above the tunnel) so as to overflow the banks of the same. A cross section of the circular inverted siphon, showing its relation to the water line and tunnel, and a plan of the mouth of the siphon enlarged so as to overcome the entry head is shown by the accompanying cut. The gradient or slope of the siphon is very light, only .0003788 ft., which made it necessary not only to build the conduit of large dimensions, but also to reduce the friction as much as possible by a bell-shaped mouth at each end, with an entry and effluent box 12 ft. sq. at the top and 11 ft. in depth, of the form shown by the cut. The method of construction was as follows: (1) As much of the space occupied by the siphon as was situated below the bottom of the tunnel was excavated, the material excavated being used in backfilling the space between the external face of the siphon and the internal face of the tunnel. This excavation was neatly trimmed to the exact dimensions of the exterior of the conduit. (2) This portion of the conduit, which was a little more than one-half of the cross section of the conduit, was then lined with concrete. A circular wooden form, the outside surface of which corresponded with the inside dimensions of the conduit, was carefully placed in position, and the concrete tamped in layers not exceeding 4 ins. in thickness behind the form. (3) A circular segment of the dimensions of the remainder of the cross section was then placed in position and the concrete tamped around the outside of the form in layers as before. The work was done in sections 12 ft. in length.



The backfilling was done in layers not exceeding 6 ins. in thickness, each layer being thoroughly tamped with a hand tamper before a succeeding layer was put on. This system of filling was carried up to a level 1 ft. above the top of the conduit, and the remaining depth was filled by pushing the dirt back until the space was filled, the earth excavated in a new section being used in backfilling the section last completed. The forms were safely removed 48 hours after the completion of a section. In the construction the work was begun in the center of the tunnel and prosecuted from both ends, the concrete being mixed at each end and carried in on tram cars as needed. The work was finished within 40 days after its commencement. The concrete was made of a combination of 7 parts of clean coarse gravel and sand, with 1 part of cement, no gravel being used that would not pass through a ring 2½ ins. in diameter.

In addition to the siphon a sand trap, 500 ft. in length, was constructed at the same time immediately below the tunnel, having its discharge into a deep ravine. This trap was made of the form and dimensions shown in the cut. The bottom of the trap is on the same plane as the bottom of the siphon, having a depth below the grade line of 5 ft. and a bottom width of 2 ft., with side slopes of 1 to 1. It is lined with concrete 4 ins. in thickness, tamped firmly against the trimmed face of the earth banks.

There are two relief gates, 2 ft. 4 ins. in width, for flushing this basin and clearing it of sand. These gates are made of wood sliding in a wooden frame, which is embedded and entirely surrounded with concrete, the bulkheads and discharge apron being made entirely of concrete. Water has been flowing continuously through the above described works since April 15, 1892, and everything has been found to work satisfactorily, as planned. An inspection made about Dec. 1, 1892, showed the work to be intact, and in perfect condition.

STANDARD GAGE ENGINES FOR BROAD GAGE TRACK; GREAT WESTERN RY.

The change of gage on the Great Western Ry., of England, by which the last remaining 200 miles of Brunel's original 7-ft. gage were converted to standard gage in May, 1892, was described in our issue of Aug. 25, 1892, and it was shown that a considerable amount of rolling stock had also to be renewed or changed at the same time.

The ultimate abandonment of the remaining portions of the 7-ft. gage on its system had been foreseen by the Great Western Ry. Co. for some years, and all new equipment for the broad gage had been built with a view to conversion to standard gage. With the cars this was effected by placing the ordinary standard gage bodies on broad-gage frames and trucks, so that when the broad-gage cars were no more needed the car bodies could be fitted to ordinary frames, with rigid axles or trucks ("bogies"), as the case might be. In 1891 there were eight convertible locomotives built at the works of the company, at Swindon, to the design of Mr. William Dean, Locomotive Superintendent, and since the final change of gage in May, 1892, these engines have been converted to the standard gage and put in service with the ordinary engines.

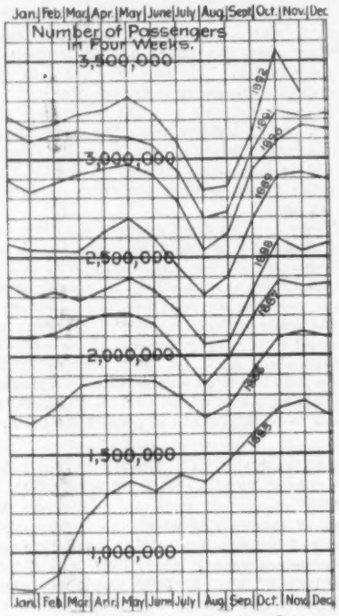
They are inside cylinder engines with cylinders inclined 1 in 33; they have a single pair of driving wheels, with a single pair of leading and trailing wheels, the axles of these wheels having lateral play. There are double frames, and as used on the broad-gage tracks, the wheels were outside the outer frames, with inside bearings only, carried in the outer frames. When converted, the two frames were placed a little farther apart and the wheels placed between them, the axles having inside and outside bearings. The general dimensions of the engines are as follows:

Driving wheels, diam.	7 ft. 8½ ins.
Leading and trailing wheels	4 " 7 "
Wheel base	18 " 6 "
Weight on leading wheels	29,568 lbs.
Weight on driving wheels	42,560 "
Weight on trailing wheels	26,880 "
Weight, total	99,008 "
Cylinders (inclined 1 in 33)	20 × 24 ins.
Boiler, diam. of barrel	4 ft. 3 ins.
Boiler, thickness of barrel plates	7-16 ins.
Working steam pressure	160 lbs.
Firebox (copper)	5 ft. 8 ins. × 3 ft. 4 ins.
Tubes, (iron); number	245,
Tubes, length..11 ft. 9¼ ins.; diam.	1⅞ ins.
Grate area	20.8 sq. ft.
Heating surface, tubes	1,321 " "
" " firebox	124 " "
" " total	1,445 " "
Capacity of tender tank	3,600 gallons

EIGHT YEARS' TRAVEL OVER BROOKLYN BRIDGE.

The accompanying diagram, reproduced with omission of some details from the last report of the Brooklyn Bridge trustees, shows in an interesting way the growth of the cable railway traffic over the bridge and its distribution by seasons. The diagram as constructed will be seen to divide the year into 13 periods of four weeks each, in order to give "months" of equal length, but to avoid repeating dates at 13 different points on each line we have added a scale of months at top and bottom, lines connecting which would give for each line about the beginning of each calendar month.

It is to be noted that the bottom of the diagram does not extend quite down to the base line; but



Eight Years Travel Over Brooklyn Bridge.

even allowing for this fact, if it be remembered that agitation for enlarged transit facilities over the bridge began in 1886, because it was even then considered over-crowded, the amount of increase which has been found to be possible since, by more and more crowding, is striking. Could the same diagram be given by hours, however, it would be found that most of the increase of recent years has come by heavier traffic in the "off-hours," and that the traffic in the rush hours has grown comparatively little, for lack of any chance to grow.

The falling off in summer will be seen to be very great, and rather tending to increase. At the first glance, the summer decrease seems to be very rapidly growing, but it is to be remembered that as the totals become greater the depression caused by a constant percentage of summer decrease is greater. The decrease, of course, is due chiefly to summer vacations, which, for 1891, reduced the average travel for four weeks from 3,150,000 to 2,700,000, or nearly 15%, and this for a mean period of fully three months. This is equivalent to 45% decrease for one month, or about 100% decrease for two weeks, which is doubtless about the mean length of vacation for the average patron of the bridge; but this vacation is distributed in time all the way from May to October, being by far the heaviest in July and August.

As of interest in the same connection, and as illustrating how enormously the traffic varies from hour to hour, we reproduce herewith a diagram recently compiled by Mr. J. J. R. Croes, showing the variations of the New York city elevated traffic. How greatly this hourly fluctuation complicates the problem of affording adequate transit is indicated by a glance at the diagram, which sufficiently explains itself. We have published various other diagrams showing similar facts to those here given at intervals during the past five years, and by referring back to these the main facts as to general experience with this class of traffic in this and other cities are pretty well exhibited.

THE EFFECT OF FROST ON THE SEWAGE FILTRATION BEDS AT SOUTH FRAMINGHAM, MASS.

One of the most serious drawbacks in connection with the purification of sewage by intermittent downward filtration through unprotected sand beds, or by broad irrigation, is the trouble which is sometimes caused by frost in cold climates.

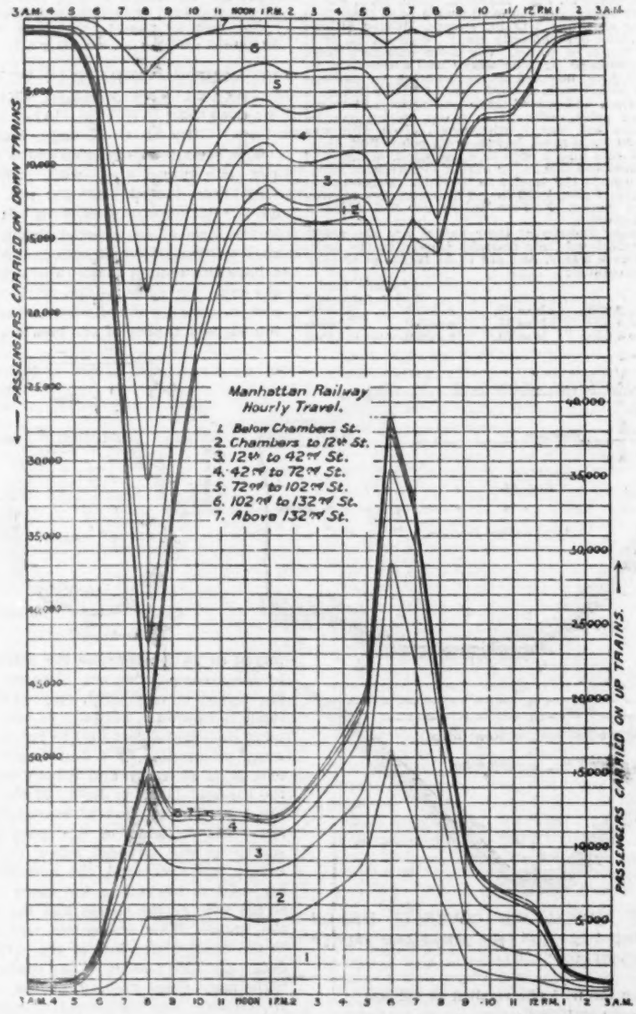
During the cold weather of January, 1893, some observations of the effect of frost on filter beds were made by the Sewer Commissioners of South Framingham, Mass., at the suggestion of Mr. Allen Hazen, Chemist of the Lawrence Experiment Station of the State Board of Health. The results of these observations were published in the Framingham "Gazette," from which the following has been abstracted:

A filter bed with an area of seven-eighths of an acre received no sewage from some time in September until Jan. 9. On this date there were 18 ins. of frost in the bed and 10 ins. of snow upon it, the thermometer reaching 6° F. below zero. On Jan. 9, 300,000 gallons of sewage were applied to the bed, and on Jan. 10, 150,000 gallons. It is said that the effluent appeared in the underdrain in six hours after the application of the sewage. On Jan. 11 the frost was entirely out of the bed in places, and on Jan. 12 it was nearly all gone and the sewage had all disappeared. The temperature of the sewage was 50° F.

On Jan. 16, 17 and 18 observations were made on another bed, with an area of one acre. The frost in this bed was from 20 to 30 ins. deep, and there was 15 ins. of snow upon it. On Jan. 16 the thermometer was 6°, on Jan. 17, 20°, and on Jan. 18, 4° F. below zero. On Jan. 16, 500,000 gallons of sewage, at a temperature of 49° F. were pumped upon this bed, and on Jan. 17, 175,000 gallons. The underdrain started in seven hours after beginning the application of sewage. On Jan. 18, the frost had gone in places, and on Jan. 19 nearly all of the frost had disappeared, and the sewage had entirely disappeared.

The results of these observations appear to show that where an unusually large volume of sewage can be applied to a filter bed in a short time the sewage will pass through the bed, even in extremely cold weather.

At the South Framingham pumping station an underground reservoir provides storage for about 430,000 gallons of sewage, which, with the sewage delivered during pumping, would allow the application of 500,000 gallons of sewage to one bed in about six hours. This amount of sewage was applied to one of the beds, with an area of one acre, in one day, and 175,000 gallons additional on the following day. The application of so large a volume of sewage at a temperature of about 50° F. in so short a time was certainly favorable to the passage of the sewage, but the presence of 15 ins. of snow was decidedly unfavorable. It seems likely that the sewage found its way under the snow upon the bed without being much chilled, as previous reports state that the sewage at South Framingham commonly creeps under the snow, so that the beds appear to be covered with snow, only, and to have no sewage upon them. In the above experiments much of the sewage doubtless went down in spots, and all of it may have passed through the beds with only a very partial purification.


PASSENGERS CARRIED ON DOWN TRAINS
PASSENGERS CARRIED ON UP TRAINS.
Manhattan Railway
Hourly Travel.
1. Below Chambers St.
2. Chambers to 12th St.
3. 12th to 42nd St.
4. 42nd to 72nd St.
5. 72nd to 102nd St.
6. 102nd to 132nd St.
7. Above 132nd St.

DIST IBUTION OF TRAVEL BY HOURS AND LOCALITIES, MANHATTAN ELEVATED RAILWAY.

In the last report of the Massachusetts State Board of Health, Mr. Allen Hazen states that, as the results of experiments at Lawrence, it has been found that "frost checks both purification and nitrification, although the removal of organic matter is more complete than the oxidation of ammonia."

In winter, especially where sewage effluents are not discharged into water used for domestic purposes, a high degree of purification is obviously of less importance than in summer.

The sewage purification works at South Framingham were fully described and illustrated in our issue of Aug. 11, 1892.

Mr. John H. Goodell is Chairman of the South Framingham Sewer Committee, and we are indebted to him and to Mr. F. P. Stearns, M. Am. Soc. C. E., for courtesies in connection with the above information.

WORLD'S COLUMBIAN EXPOSITION.—III.

Regulations Governing Awards.

The Director-General, Mr. George R. Davis, has issued a circular stating the arrangements made for judging the exhibits and awarding prizes. In accordance with the determination of the commission appointed to consider this matter, and to decide whether juries or individual judges should make awards, it is provided that awards shall be granted upon specific points of excellence or advancement formulated in words by a board of judges or examiners, who shall be competent experts. This board of judges will be composed, so far as practicable, of competent experts, and will be divided into 13 committees, one of which will be assigned to each of the 13 great departments of the Exposition, as recognized by the classification adopted by the World's Columbian Commission. The number of judges composing this board and each committee thereof will be determined later. There will be one or more women judges upon all committees authorized to award prizes for exhibits which may be produced in whole or in part by female labor; and the number of women upon such committees will be determined according to the method already prescribed by the commission, after conference with the president of the Board of Lady Managers and the Awards Committee thereof.

The individual members of the 13 committees will be, so far as possible, competent experts, and will perform such duties and examine such exhibits as shall be assigned them by the Executive Committee on Awards. There will be a foreign representation upon each one of these 13 committees, and the number of foreign judges will be fixed when the character and extent of the participation of the various foreign nations have been ascertained. Each committee will, at the call of the Executive Committee on Awards, organize by the election of a president, vice-president and secretary, and is to keep a record of all returns and reports by the individual judges. It will be the duty of each individual judge to make a report in writing, over his signature, of the result of the examinations of each exhibit primarily examined by him, as each examination is completed; and as to every exhbit so examined which he shall deem worthy of an award, he is to formulate in words its specific points of excellence or advancement, and which, in his opinion, render it worthy of an award. Every report must be submitted as soon as possible to the committee of which the judge is a member; and in every case where, by the vote of the majority of such committee, it is determined that an exhibit is worthy of receiving an award, the committee must forthwith formulate in writing the specific points of excellence or advancement which, in its opinion, warrant the award, and transmit the same to the Executive Committee on Awards. In case the finding of the committee differs from the conclusion of the individual judge making the preliminary examination, either as to its being worthy of an award or as to the character of the points of excellence or advancement it possesses, it must be so distinctly stated in the report of the committee. In every case where the finding of the departmental committee coincides with the conclusion of the individual judge, the committee will transmit, with such finding, the report of the judge to the Executive Committee on Awards; and in those cases where the finding of the departmental committee does not coincide with the conclusion of the individual judge, then the finding in each such case is to be accompanied by the written report of one of its members who shall have examined the exhibit, formulating therein the specific points of excellence of advancement possessed by such exhibit.

The Executive Committee on Awards has communicated, through the Dictator-General, with the foreign governments which have appointed commissions to represent them at the World's Columbian Exposition, or with these commissions directly, stating the character of the awards, the grounds upon which they are to be granted, and the requirement that all judges shall be, so far as practicable, competent experts; and the foreign governments were invited to recommend, previous to March 1, experts in the various departments, and from those named the Executive Committee on Awards may make selections. There will be but one class or kind of medals, which will be made of bronze and will be works of art, and will be accompanied by parchment diplomas, on which shall be formulated the specific points of excellence presented by the exhibit receiving the award. The medals and diplomas are to be awarded by authority of Congress, and are prepared under the direction of the Secretary of the Treasury. Should any exhibitor, domestic or foreign, become a judge under these rules, the exhibit will be excluded from examination for award, but the Executive Committee on Awards may cause such exhibit to be examined, and a report thereupon made to complete the history of the Exposition. Any exhibitor may have his exhibit exempt from examination for award by notifying the Executive Committee on Awards; otherwise that committee will have the right, through its regularly appointed judges, to examine every exhibit, domestic or foreign.

The work of the judges is to commence not later than June 1, 1893, and shall progress uninterruptedly until the completion of the work assigned them, except in the Department of Live Stock, and in those departments where the nature of the exhibits requires renewal from time to time during the Exposition. Upon the completion of the work of the judges the results will be presented by the Executive Committee to the full Committee on Awards, which will, in turn, report to the World's Columbian Commission, or, in its absence, to the Board of Reference and Control, by whom the formal promulgation of the awards and the distribution of medals and diplomas will be made with appropriate ceremonies.

In addition to the reports by the individual judges of the various exhibits, each of the 13 committees is to present a comprehensive report embodying the principal educational and interesting features of the groups and classes composing that department, accompanied by a list of exhibitors who have received awards, with the reports of the individual judges giving the reasons and considerations therefor; and this report must be delivered to the Director-General to be included in and to form part of the history of the Exposition; but this is not to prevent or interfere with the duty expected of each chief of department to prepare and submit, as part of the official history of the Exposition, a complete and comprehensive report of the work of his department.

It is the desire of the World's Columbian Commission to compensate judges, but this will depend upon the action of Congress, to which application has been made for an appropriation sufficient to defray all expenses connected with this subject of awards. Should the appropriation be made, judges from the United States will receive $800 each and those from foreign countries $1,000 each.

Management of this whole matter is in the hands of the Executive Committee on Awards, which is receiving applications for appointments as judges at its temporary offices in the capitol at Albany, N. Y. After March 15 the office will be permanently established in the Administration Building of the World's Columbian Commission, at Jackson Park, Chicago. As the judges are to be, so far as possible, competent experts, and the duties of the position require efficiency and ability of a very high order, and it is the desire of the Executive Committee to appoint only those absolutely qualified for the place and, whenever possible, of national and international reputation, the Executive Committee has considered it a duty to call the attention of the technical journals of the country to the facts in order that it may receive the assistance and co-operation of those who, by their position and connections, are best able to assist the committee. Mr. John Boyd Thacher, Albany, N. Y., is Chairman of the Executive Committee on Awards.

Financial Statement.

The following table is an abstract of the published report of Mr. Ackerman, the auditor, giving the financial condition up to the end of January, 1893. The construction expenses during the month of January were $970,908.49. The expenditures for the month, both on account of construction work and administration (or general expenses), $1,131,284.30. During January a force of 2,784 men were given employment by the Exposition. The compensation for the month was $222,575.29, being an average of $2.58 per day for each employee. The auditor's statement is as follows (omitting the cents for the sake of clearness):

Capital stock	$5,509,767
City of Chicago—proceeds of appropriation	5,000,000
Souvenir coins, deposits on account of	817,937
Debenture bonds, 6% due Jan. 1, 1894	3,557,500
Interest on deposits and exchange	76,919
Miscellaneous Receipts.	
Forfeits on contracts	$300
Gate receipts	191,808
Materials sold	3,021
Electric power furnished	5,815
Operating railway—(switching) gross receipts	24,524
Concessions, etc	15,516
	$251,007
Liabilities	$305,043
Total receipts	$15,517,604
Disbursements.	
General expenses	$1,878,576
Preliminary organization expenses	99,674
Construction Expenditures.	
Administration Building	$404,408
Agricultural Building	655,675
Architects' fees	31,350
Art Building	557,428
Art Institute	86,493
Board of architects	121,547
Bonded warehouses	11,706
Boiler house	29,586
Boiler plant	38,494
Bridges	66,783
Building implements and tools	5,434
Claims and damages	4,500
Colonnade and obelisk	81,389
Coloring and decorating	141,796
Carpenter shop	9,162
Dairy Building	24,767
Dairy barns	45,775
Damages to property	1,857
Draftsmen's materials	11,430
Draftsmen's wages	142,946
Dredging, filling and excavating	573,159
Elevation of Illinois Central R. R. tracks	107,347
Electrical engineering	48,960
Electricity Building	446,428
Electric plant	284,300
Engineering expenses	55,418
Engineering implements and tools	5,789
Fencing	23,353
Fire and police houses	33,083
Fire plant	2,502
Fire protection	133,039
Fisheries Building	211,811
Floating property	70,551
Floricultural gardening	28,202
Furniture for buildings	15,705
Forestry Building	80,212
Fountains	51,417
Freight sheds	29,089
Gardening implements and tools	3,980
Greenhouses	963
Grading and surveying	73,643
Grounds and Buildings Office	80,937
Hauling materials	10,647
Horses, wagons, and other vehicles	27,578
Heating offices and buildings	22,542
Horticultural implements and tools	529
Horticultural gardening	991
Horticultural Building	292,211
Hyde Park police station	37,771
Installation of exhibits	5,070
Interior docking	203,190
Intramural water transportation	751
Krupp's pavilion	1,948
Lake-front improvement	4,616
Landscape architecture	20,244
Landscape gardening	371,501
Live-stock Exhibit Building	30,007
Machinery Building	978,406
Manufactures Building	1,558,433
Maps and plans	27,004
Mechanical engineering	32,004
Mechanical implements and tools	4,424
Medical and surgical attendance	10,984
Music Hall, Casino, and Peristyle	246,054
Mines and Mining Building	265,547
Office building for mechanical and electrical departments	8,250
Operating railway	38,071
Operating launches	3,175
Oil plant	25,180
Piers and breakwaters	260,708
Plaster modeling and implements	2,278
Photographers' Building	6,039
Photographical labor and materials	6,042
Police signal boxes	8,881
Police protection	232,521
Power plant, Machinery Building	149,067
Perron and trainsheds	9,900
Pumping station	35,691
Propagating houses	17,463
Permanent power	3,414
Personal injuries	1,806
Runways and cranes, Machinery Hall	79,474
Railway tracks	296,433

Railway terminal station	80,715
Right of way	51,592
Reproduction of the La-Rabida Convent	15,093
Real estate	10,325
Rent of ground	26,896
Rockery, Horticultural Building	157
Roadways and sidewalks	149,606
Saw mill	11,525
Sculpture modeling	189,587
Sewage purification works	14,857
Service stables	10,224
Shoe and Leather Building	28,875
Stable expenses	23,841
Silo building	3,282
Storage house for empty packing cases	15,717
Statues	126,017
Storage building	10,848
Superintending construction	157,788
Surveying and examining sites	2,262
Temporary buildings	54,563
Temporary sidewalks and roadways	9,892
Transportation Building	464,738
Turkish mosque	2,476
Uniforms	10,762
Van Buren St. pier	42,079
Water and sewerage	613,219
Water supply	201,883
Woman's Building	126,589
Woodlawn police station	17,799
Total disbursements	$14,593,317
Balance on hand	$924,646

Painting the Buildings by Machinery.

In order to economize time in painting the great area of the surfaces of the walls of the main buildings, experiments were made in the application of the coloring material by means of compressed air, and these experiments proved so successful that this novel and interesting method has been very extensively used. The following is an abstract of an article in "Harper's Weekly," which explains the methods adopted with sufficient clearness; and the accompanying sketch shows the general arrangement of the apparatus:

In the painting of the buildings the necessity for some method of covering their great areas which would be more rapid and less expensive than the brush was realized almost from the beginning of construction. Where such extensive wooden construction is used it is impracticable to dress all surfaces, and there exist many spaces inaccessible to the brush; while the rough or "whiskered" lumber makes the life of the brushes exceedingly short.

As soon as the placing of foundations had been commenced, careful consideration was given this subject, and efforts made to perfect a painting-machine, but the earlier experiments were far from successful, and it was not until the buildings were nearly ready for their decoration that the subject was again taken up. Additional impetus was given by the fact that there remained insufficient time before the opening of the exposition to accomplish so vast a work by hand. Some weeks were occupied in further experiments, Mr. F. D. Millet, Director of Decoration, and his assistant, Mr. C. Y. Turner, giving much attention to the problem. Meanwhile, the painting of the buildings then near completion progressed as rapidly as possible by hand in the usual manner. Finally, a machine which successfully sprayed color upon the surfaces to be covered, on the same general principle as the "atomizer," was produced and immediately set to work. In this first successful apparatus, the color (in nearly all cases kalsomine) was passed directly through the rotary engine used for compressing air; but, because of its gritty nature the wear was so great as to become a serious objection, and to render a more satisfactory method of introducing the color necessary, and further improvements were made, with successful results.

A rotary engine invented by Mr. T. G. Turner, of New York, driven by a 5-HP. electric motor, provides the compressed air in cases where the pneumatic system of the Exposition is not available. This engine furnishes the required pressure in a uniform manner, without the air-chamber necessary to overcome pulsation in compressors operated upon the reciprocating principle. The engine, electric motor, color reservoir, etc., are mounted upon a truck, which is readily moved from place to place. Into the reservoir the kalsomine is poured after having been properly mixed, and through it, from the bottom, there is forced a jet of air at a pressure of 18 to 20 lbs. per sq. in. In this manner the contents are kept agitated, and any deposit of sediment prevented. From the top of the reservoir the air is then conducted through a pipe to a point on the outside near the base, and here, by means of a ¼-in. regulating valve, the color passes into the main air pipe, where it unites with the compressed air, forming a spray which passes into an ordinary ¾-in. garden hose of any desired length. At the end of this hose is attached a nozzle, consisting of a brass pipe flattened out so as to leave an aperture 1-16 in. wide and about 1½ ins. long. One machine furnishes spray for two nozzles, each being operated by a skilled painter, who applies the color as one would handle a lawn-sprinkling hose. While trained painters are not absolutely necessary to the proper operation of the appliance, it has been found that better results are obtained by their employment. From ordinary scaffolding, the color is sprayed upon the woodwork in sections, the machine being moved as work progresses.

In many cases in the main buildings the use of a separate compressor has been unnecessary, the Exposition having in operation throughout the grounds underground pipes supplying compressed air for the operation of the ejectors in connection with the sewerage system. Where this power is available, the process is the same, except that the compressed air is heated by means of a coil adjusted in a salamander containing a coke fire. This secures the proper temperature, and enables the machine to work in very cold weather, when hand-painting is impossible. Heating is not required where individual compressors are used, because the friction of the machine raises the temperature of the air to the required point.

There are now at work within the grounds 14 machines, each with a force of three men, covering an average of 140 sq. ft. per working day of eight hours. A comparative test recently made showed that one painter could cover with a brush a daily average of about eight squares, while a machine upon similar work accomplished with equally satisfactory results nearly twenty times this amount, there being, however, two nozzlemen for each machine. As high as 304 squares have been done by one machine in eight hours, but this was an exceptional case, where all conditions were favorable for rapid work. On Dec. 8, 1892, a number of machines began work upon the interior of the Manufactures Building. At the end of three weeks, with a daily average of about 30 men, 1,332,669 sq. ft., half of the entire surface to be covered, had been finished. One of the advantages of this system is that in the coldest weather, when brushes are frozen solidly in transit from pail to wall, the machine work goes actively ahead.

The only comparison between machine and brush whereby the former suffers is in the amount of material used. Where 20 barrels of kalsomine are required for hand work, the machine will use 21. With a saving, however, in time and labor of about 20 to 1, the small amount of waste in material is scarcely worthy of consideration.

State Appropriations.

Every state and territory has arranged to make some sort of an exhibit at the Exposition, and many of them will have a display in several of the departments, and will also have special buildings for their headquarters. When the first appeal was made for state appropriations it was estimated that $4,000,000 might be raised for special exhibits, but already $4,813,250 has been devoted by the several states to the Exposition work, and further appropriation of about $1,290,000 is expected. The following table shows the appropriations, etc., of the several states. The cost of buildings includes donated material:

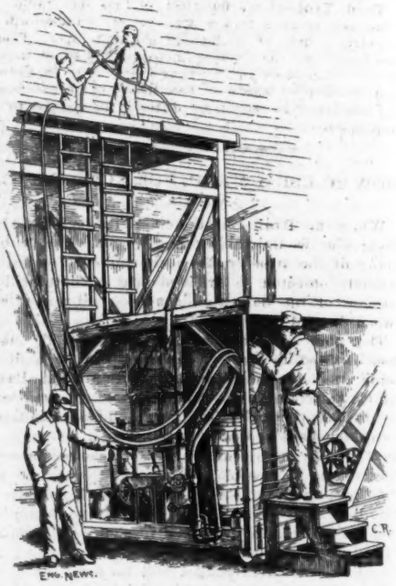
States.	Appropriation.	From other sources.	Total expenditures.	Cost of Building.	Appropriations expected.
Alabama	None.	*$20,000	$20,000	$15,000	$25,000
Arkansas	None.	*10,000	40,000	18,000	15,000
California	300,000	†250,000	550,000	75,000	.....
Colorado	100,000	†50,000	150,000	35,000	100,000
Connecticut	None.	*50,000	50,000	15,000	50,000
Delaware	10,000	.....	10,000	8,000	15,000
Florida	None.	*50,000	50,000	.....	.....
Georgia	None.	*100,000	100,000	50,000	50,000
Idaho	20,000	*50,000	70,000	30,000	80,000
Illinois	800,000	None.	800,000	250,000	.....
Indiana	75,000	10,000	85,000	75,000	100,000
Iowa	130,000	Some.	130,000	50,000	.....
Kansas	None.	100,000	100,000	20,000	100,000
Kentucky	100,000	75,000	175,000	35,000	.....
Louisiana	36,000	.....	36,000	.....	.....
Maine	40,000	None.	40,000	22,000	22,000
Maryland	60,000	None.	60,000	35,000	.....
Mass	150,000	None.	150,000	65,000	.....
Michigan	100,000	125,000	225,000	50,000	50,000
Minnesota	50,000	100,000	150,000	25,000	.....
Mississippi	None.	*25,000	25,000	15,000	.....
Missouri	150,000	None.	150,000	100,000	.....
Montana	60,000	None.	50,000	15,000	Some.
Nebraska	50,000	None.	50,000	15,000	.....
Nevada	None.	Some.	.....	.....	Some.
New Hamp.	25,000	20,000	45,000	10,000	.....
New Jersey	70,000	None.	70,000	40,000	.....
New York	300,000	None.	300,000	100,000	300,000
N. Carolina	25,000	20,000	45,000	10,000	Some.
N. Dakota	25,000	30,000	55,000	25,000	.....
Ohio	125,000	None.	125,000	50,000	75,000
Oregon	None.	Some.	.....	.....	.....
Pennsylv'nia	300,000	None.	300,000	80,000	.....
Rhode Island	50,000	None.	50,000	15,000	Some.
S. Carolina	None.	50,000	50,000	10,000	.....
S. Dakota	None	25,000	25,000	25,000	70,000
Tennessee	None.	Some.	.....	20,000	25,000
Texas	.....	.....	.....	.....	.....
Vermont	29,750	10,000	39,750	10,000	.....
Virginia	25,000	50,000	75,000	25,000	25,000
Washington	100,000	Some.	100,000	50,000	50,000
W. Virginia	40,000	None.	40,000	20,000	.....
Wisconsin	65,000	15,000	80,000	30,000	135,000
Wyoming	30,000	Some.	30,000	.....	.....
Arizona	30,000	.....	30,000	7,500	.....
New Mexico	25,000	10,000	35,000	.....	.....
Okla. Ter	.....	2,500	2,500	.....	.....
Utah	.....	50,000	50,000	15,000	.....
Total	$3,485,750	$1,327,000	$4,813,250	$1,550,500	$1,293,000

* By subscription. † By counties, etc.

PETROLEUM ENGINES.

The following is an abstract of a paper read before the Liverpool Engineering Society, on Jan. 25, by Mr. J. F. Conradi. The Priestman engine has been described in our issue of Nov. 17, 1888, and Sept. 1, 1892. The Daimler petroleum engine was described and illustrated in our issues of Nov. 24 and Dec. 22, 1892. The use of petroleum fuel was described in our issue of Aug. 25, 1892:

Petroleum or rock oil is found in America and in Russia by sinking wells. It was previously obtained by the distillation of bituminous shale found in Scotland. The former is the "refined petroleum"; the latter is often called paraffin oil. The American petroleum yields on distillation far greater quantities of burning oils than the Russian oil. We obtain greater quantities of lubricating oils from the Russian petroleum. The following are the products: 1, Light oils—gasoline, naphtha, petroleum spirit (highly inflammable, low flashing point, used in Spiel's naphtha engine). 2, Burning oils of commerce—kerosene, etc. (safe oils), used in petroleum engines by being converted into vapor at low temperatures. 3, Intermediate oils. 4, Lubricating oils. 5, Paraffin wax (from shale), vaseline from refined petroleum). 6, Residuum, the liquid fuel most successfully used in Russia, and also used in England on locomotives by being injected by a powerful



Painting by Machinery; World's Columbian Exposition.

steam jet into the furnace. Petroleum places at the engineer's disposal a fuel of higher calorific value than coal—about 25% higher.'

Russolene oil	19,500	thermal units
"Royal daylight" oil	19,700	"
Coal	14,500	"

An essential feature of the Priestman engine is that, although it is undoubtedly an internal-furnace engine, the total heat of the working fluid is not quite developed in the working cylinder—some is supplied in the vaporizer. The following classification is dependent upon how the oil is treated before explosion in the working cylinder.

First Type.—The oil is split up into a spray cloud—really minute particles of the oil suspended in air—then vaporized, mixed with proper proportions of air, then admitted into the working cylinder, compressed and fired. Such are the Otto and Priestman engines. The former is the simplest and most successful form. It consists essentially of a spraymaker and vaporizer, air-pump, working cylinder and gear. The spraymaker consists of an air passage and oil passage. The oil passage at the nozzle is diminished. The nozzle or mouthpiece or point of issue of the oil is re-entrant, as is also the nozzle of the air passage. The oil nozzle fits inside the air nozzle, so as to allow a small amount of re-entrant air passage. The air is supplied from the air space above the oil in the oil tank, comes round the oil nozzle through the re-entrant air passage, meets the oil in the form of a very fine jet, and splits it up in the form of a very fine spray. The air mouthpiece is re-entrant, and the air at the point of issue is made to turn through an angle greater than a right angle. This spray is discharged into the vaporizer (which is heated by the exhaust gases playing round

lt), then mixed with proper proportions of air, which comes through a non-return valve, and drives the spray cloud into the vaporizer. The charge is then drawn through an automatic suction valve, compressed, and fired electrically. The cycle used is the ordinary "Otto" cycle. The power is regulated by a governor acting on an oil plug through which is a peculiar V-shaped passage. The governor simultaneously actuates the throttle valve of the air supply. The efficiency of this oil engine is 84%; exhaust waste is 30%; heat utilized, as shown by indicator diagrams, 16%; useful work at brake, 12½%. About 1 lb. of oil is used per brake-horse power per hour. Cost of oil per brake per horse power per hour is 1 ct. These figures are calculated from tests made by the author on a 12½-I. HP. oil engine.

Second Type.—Oil is injected in the liquid state into a hot cartridge at the end of the cylinder, here it is gasified, mixed with proper proportions of air, compressed into this hot combustion chamber and explodes, as the Hornsby-Akroyd oil engine. No igniting gear is used; a high compression such as is used is sufficient to explode the red hot charge. The vaporizer is of cast iron, provided with radial ribs, offers a large heating surface, and communicates directly with the cylinder. The out stroke of the piston draws in air through air inlet valve, and the oil is injected simultaneously into the vaporizer. The return stroke compresses the charge, which has become vaporized, and explodes at the end of the stroke. This is also an efficient and simple form of oil engine.

Third Type.—A carburetter, or gas generator or vaporizer, consists of a heated coil or chamber which converts a drop of oil into oil gas and vapor. These are drawn into the cylinder, mixed with a slight excess of air, compressed and fired, as the Trusty, Capitaine, and Crossley oil engines. The disadvantages of these engines are that the tarry products soon make their presence felt.

HOW TO USE A T-RAIL FOR STREET RAILWAYS.

While the T-rail, on account of its stiffness and cheapness, would be preferred to other forms by many of the street railway companies, its use is strongly objected to by municipal authorities on account of the dangerous spaces usually left between the rail and the pavement.

The plan here described and illustrated has been devised to meet this objection, and is now being used by the Warren-Scharf Asphalt Paving Co., of New York. An iron chair or a wooden stringer of proper width, resting upon cross-ties, forms the base support for the T-rail, and brings the head of the rail on a level with the pavement. Single rows of paving blocks are laid on each side of the rail, with the outside row laid as header and stretcher. The inside row is laid as stretchers, with thick and thin blocks alternating, and these inside blocks are set ½ in. below the head of the rail to allow for the flanges of the wheels.

For a depth of within 2½ ins. of the top of the rail the space between the paving blocks and around the rail is filled with hydraulic cement grout. Above this, and to the level of the top of the paving blocks, a special Trinidad asphalt composition is poured and tamped around the rail. Whether an iron chair or wooden stringer is used under the rail, the space between the rail and the paving blocks must not exceed 1¾ ins. The plan here described is intended for use with asphalt pavement for the street and between the rails, or the blocks lining the rails.

Street Railway Track with T-Rails.

Railway tracks so constructed offer as little obstruction or danger to vehicles as the girder or any other form of rail, excepting, perhaps, the English grooved rail. Portland cement mortar and concrete have been tried for filling in this rail space, but failed because this material lacked the essential qualities of elasticity and malleability. As prepared for sale, the special composition here recommended is shipped in barrels. It needs only to be melted and poured, and the only special tools required are a kettle, or "mastic pot," and a stirrer. This material has been satisfactorily used with the T-rail in Utica, and in Amsterdam, N. Y.

The New York state dam, across the Hudson River, at Cohoes has shown signs of weakening for some time. The State Engineer, Mr. Schenck, recommends that $90,000 be appropriated for tearing down and rebuilding 1,060 ft. of dam that requires it, and the raising and repair of the old apron, and the building of a new apron where none now exists.

PERSONALS.

Mr. George Bowers has been appointed City Engineer of Lowell, Mass.

Mr. Chas. Kellogg, President of the Elmira Bridge Works, Elmira, N. Y., has resigned.

Mr. Francois Van Rysselberghe, a well known Belgian electrician, died at Antwerp, Belgium, Feb. 3, at the age of 45.

Mr. O. Wolff, civil engineer, of Copenhagen, Denmark, is visiting this country to investigate sewerage systems and water-works.

Mr. F. W. Gilcreast has been appointed Division Engineer of the Mahanoy, Beaver Meadow and Hazleton Divisions of the Philadelphia & Reading R. R., with office at Delano, Pa.

Mr. John J. McDonald, railway contractor, died at Montreal, Feb. 9, at the age of 57. He was engaged in the construction of the Intercolonial Ry. and the Canadian Pacific Ry.

Dr. John J. Craven, who was at one time prominent in military and scientific circles, and who superintended the building of the first telegraph line between New York and Philadelphia, died at Patchogue, L. I., Feb. 14, at the age of 71.

Mr. Samuel M. Gray, of Providence, R. I., has been employed by the city of Meridian, Miss., to submit plans, etc., for a sewerage system. Mr. N. M. Brandon, the City Engineer, will furnish the topographical map, profile and other necessary data.

Mr. J. R. Matlack, Jr., will act as representative of the Riehle Bros. Testing Machine Co., at the World's Columbian Exposition. His headquarters previous to the opening of the Exposition will be at the office of R. W. Hunt, Rookery Building, Chicago.

Mr. J. Van Smith, Superintendent of the Philadelphia Division of the Baltimore & Ohio R. R., has been appointed, in addition to this position, General Agent of the company for Philadelphia, with office at the Baltimore & Ohio R. R. Station, 24th and Chestnut Sts.

Mr. Lewis H. Davis, has been appointed Mechanical Engineer of the National Lead Co., with headquarters at No. 1 Broadway, New York. He was formerly with Mr. John W. Hill, of Cincinnati, and later was Engineer for the Dalton, Ga., Architectural Iron Works.

Mr. John M. Robinson, President of the Bay Line of steamers, died at Baltimore, Md., Feb. 14. He was born in Philadelphia, Oct. 22, 1835. His first engineering work was for the Washington Turnpike Co. On the breaking out of the war he was attached to the engineering corps of the Confederate service, reached the rank of colonel, and served as a staff officer. He was sent to Europe by the engineering bureau to purchase supplies for the Confederacy. At the close of the war he was in charge of railway transportation for the Confederacy, and was afterward made Superintendent of the Seaboard R. R.

NEW PUBLICATIONS.

STATE BOARD OF HEALTH OF OHIO: Report for 1890-91. C. O. Probst, Secretary. 8vo, pp. 334. Many tables; one folding plate.

Most of this report is taken up with general health matters. Between three and four pages are devoted to an account of investigations now being made of the water supplies of Ohio cities and towns drawing their supply from the Ohio River, of which there are ten, including Cincinnati, Portsmouth and Ironton. These investigations are being made to determine the actual quality of the water furnished consumers and whether better supplies than those now in use could be secured. In addition there may be brought out some facts regarding the prevention of further pollution of the river or the purification of water drawn from it. Both chemical and biological examinations are being made in connection with this investigation.

STATE ENGINEER OF COLORADO: Report for years 1891 and 1892. J. P. Maxwell, State Engineer; John S. Titcomb, Deputy State Engineer. 8vo, pp. 422; many tables and one folding plate.

This report contains the usual information and statistics regarding the character and extent of the irrigation works of the state, and in addition gives the results of stream gagings, observations of the amount of water returned to streams by seepage and descriptions of the state roads, bridges and irrigation works constructed or begun during the two years ending Nov. 30, 1892. One reservoir was completed and another begun in this period, each formed by earth dams. The Apishapa Creek reservoir has a capacity of 20,000,000 cu. ft., and is formed by a dam 800 ft. long, with its crest 42 ft. above its bottom. The Monument Creek reservoir will have a capacity of over 37,000,000 cu. ft., and will be formed by a dam 855 ft. long and about 40 ft. high above the surface. Sections and details of this dam appear in the report.

IRRIGATION: Part II. of the Report of the United States Geological Survey for 1889-90. By J. W. Powell, Director. 4to, pp. 395; 30 plates and four figures in the text.

In our issues of Dec. 19 and 26, 1891, there appeared a review of the work of the Irrigation Department of the United States Geological Survey up to the close of the period covered by this report. The review was prepared by Mr. H. M. Wilson, M. Am. Soc. C. E., connected with the survey, and practically included a review of this volume, which at that time had just been presented to Congress. For this reason it is only necessary to state that the report describes in detail the hydrographical, engineering and topographical work of the survey and includes, in addition, an extended bibliography of irrigation literature and the testimony of Director Powell before the House Committee on Irrigation. Three maps show irrigated, forest and drainage district areas of the so-called arid region. A few fine half-tones showing reservoir sites are given, besides which there are a number of diagrams and other illustrations.

IRON ORES OF MISSOURI: From Field Work of 1891 and 1892. With 70 Illustrations and one Map. By Frank L. Mason, Assistant Geologist. Published by the Geological Survey of Missouri. Arthur Winslow, State Geologist. 8vo, pp. xxvi., 266; eight plates, folding map of the state and 62 figures.

This volume appears to be a very complete description, both general and particular, of the iron ores of Missouri. It is not pretended that all the mines are described, or that all the localities where ore is found are listed, but the report is far more complete than any on this subject previously issued and will doubtless be of material value to the state. The numerous illustrations, line work, pen drawings and half-tones, add to the interest and value of the work.

WATER TOWER PUMPING AND POWER STATION DESIGNS: The "Engineering Record's" Prize Designs Suggestive for Water Towers, Pumping and Power Stations. New York: The "Engineering Record." One page of text and 34 of illustratoins.

This is a republication of prize and honorable mention designs received in a competition instituted by the "Engineering Record" in 1890. There were awarded four prizes and 13 honorable mentions, the competitors submitting designs for both water towers and pumping stations, so that the volume contains drawings of 17 towers and the same number of pump houses, selected from a total of 56 designs submitted. Perspective views and plans of the structures are given, and one elevation and one section of each pumping station.

All the published designs have far more architectural merit than the majority of existing structures of these classes, but most of them would prove too expensive for actual construction, and some seem wholly inappropriate for the purpose they would serve if carried out.

The drawings have been well reproduced, the presswork is excellent and the volume is tastefully bound. Mr. Dexter Brackett, M. Am. Soc. C. E., of Boston, was the only engineer or water-works man on the committee of award, the other four members having been architects. The first prize was awarded to Elmer Grey, of Milwaukee.

MINERAL WATERS OF MISSOURI: By Paul Schweitzer, Assistant Geologist. Embodying also the Notes and Results of Analyses of A. E. Woodward, Assistant Geologist. From Field and Laboratory Work conducted during the Years 1890 to 1892. With 45 Illustrations and one Map. Published by the Geological Survey. Arthur Winslow, State Geologist. 8vo, pp. xxv., 256; 23 plates, 11 figures and one folding map.

This report is a highly creditable piece of work published in a very pleasing manner. The investigations and report were made to determine the composition and character, supply suggestion regarding use and further the development of the mineral waters of the state. Chemical analyses of mineral waters from 83 sources are given, together with descriptions of the springs or wells from which they are taken, and the natural and artificial surroundings, including hotels, cottages and other improvements for visitors. Half-tone views of many of the wells, springs and hotels are given and also sketch plans of the wells or springs and vicinity, and sections through the wells and springs. In addition to the 83 water analyzed by the survey there are included 103 independent analyses, 70 of which were not included in the analyses made by the survey, so that in all, analyses of waters from 153 sources are given.

The origin, analysis and composition and therapeutics of mineral waters in general are discussed in the first 37 pages of the report. At the end of the volume there is given an extended bibliography of mineral waters

from the earliest times to 1883. A colored geological map of the state, on a scale of 18 miles to 1 in., accompanies the report upon which are shown by different symbols the location of muriatic, alkaline, sulphatic, chalybeate and sulphur waters of the state, the report classifying the waters in this manner.

TRADE PUBLICATIONS.

STRUCTURAL IRON WORK, COPPER, ETC.—Wm. B. Scaife & Sons, Pittsburg, Pa., 12mo., pp. 47; illustrated.

This is a descriptive catalogue and price list of sheet, plate, forged and structural iron, corrugated iron, copper boilers, tanks, range boilers, iron buildings, elevator buckets, the Caldwell spiral conveyors, etc.

DERRICKS AND HOISTING PLANT.—American Hoist & Derrick Co., St. Paul, Minn. 8vo., pp. 144; illustrated.

This is the company's illustrated catalogue and price list of 1893, and gives some interesting reproductions of photographs showing the application of the tubular derricks described in our issue of Feb. 2. Various types of hoisting engines are described and illustrated, as well as pile drivers, boilers and boiler fittings, derricks and derrick steps, contractors' elevators, pulley blocks, etc.

HOISTING ENGINES, BOILERS AND SUSPENSION CABLEWAYS.—The Lidgerwood Mfg. Co., New York. Paper 4to., pp. 114.

The number of uses to which hoisting engines are now days applied is astonishing even to engineers. This one firm claims an output of over 8,500 in the twelve years of its existence, and its manufacture embraces engines of all sizes and varieties from the heavy hoisting engines of 200 HP. or over, for deep mines, down to the miniature oyster packers' hoist, run by a small rotary engine. Electric hoists are offered, and sizes up to 150 HP. are listed. The company's output also includes belt hoists, log skidders, mine cars, hoisting cages and stationary engines.

FREIGHT, DUMP AND ORE CARS.—Bloomsburg Car Co., Bloomsburg, Pa. 8vo., pp. 34; illustrated.

This is an illustrated catalogue of freight, mine, dump, ore and miscellaneous cars. The company has several special forms of dump cars, including side dumps and the Lockard rotary dump car. Mine cars are of wood or steel. Lumber trucks and sugar cane cars are also built. The company also supplies the Bowden self-oiling car wheels and Subers' roller bearing for car or wagon wheels.

SOCIETY PROCEEDINGS.

NEW YORK RAILROAD CLUB.—At the meeting on Feb. 16, 21 new members were elected and 3 others applied for membership. The first question discussed was the application of dead blocks to freight cars having M. C. B. couplers, Mr. G. W. West (N. Y., Ont. & Western) applies dead blocks to every new car built and every car passing through the shops, and believed that they were a protection to men and to the couplers. President Blackall follows the same practice on the Delaware & Hudson cars; and Mr. Lewis, of the Delaware, Lackawanna & Western, does the same, and considers them absolutely necessary. Mr. Watson, of the West Shore, said that as far as safety to the men was concerned, he would remove the dead blocks; but he thought they were a protection to the coupler. Mr. West illustrated the unsettled state of opinion by saying that his company had two damage suits pending for injuries received in coupling cars; one because the cars were not equipped with dead blocks, the other because they were so equipped.

Other members urged against the dead blocks that if put on according to the M. C. B. standards, they would not come together and protect the coupler from buffing strains until the coupler was broken. If, on the contrary, they were made to project far enough to come together before the spring slack was taken up, cars would not couple on sharp curves. Those using the dead block replied to this that they did let dead blocks project as stated, and found no difficulty in coupling on curves. As for danger to those in coupling, it was not denied that the dead blocks were a protection to the men from having their bodies crushed between the ends of the cars in case the coupler or draft rigging failed to take up the shock when the cars came together. It was claimed, however, that in guiding the link men were likely to have hands or arms caught between the dead blocks, if they were careless. Mr. West, however, guarded against this by raising the dead blocks so high that there was plenty of room to handle the coupler without getting the hand between the dead blocks. Mr. Mendenhall, of the Pennsylvania, called attention to the fact that dead blocks properly put on greatly relieved the whole draft rigging and reduced the breakages. The buffing strain is the greatest which the couplers and draft gear are called on to stand. If the dead woods take the shock, it is transmitted directly to the main sills of the car, whereas if the blow comes on the coupler it is all transmitted to the draft timbers.

The question whether auxiliary draft timbers might be dispensed with, the draft gear being fastened directly to the end and center sills, was next taken up. The practice of the Chicago, Burlington & Quincy was instanced (the standard furniture car of that company is shown on this week's inset sheet) and it appeared from the discussion that quite a number of cars were in service on other roads in which this general idea had been carried out in arranging the draft rigging.

The relative merits of the tail bolt and the yoke fastening for M. C. B. couplers were then discussed and the general sentiment was in favor of the tail bolt. Its advantages are that it is simpler and a coupler can be replaced much more quickly than with the yoke. Mr. Smith, of the Union Tank Line, said he had equipped about 2,000 cars with a 2¼-in. tail bolt and two keys, one in front and one back of the coupler tail end. These prevent any motion of the bolt in the drawbar end and he had not heard of a single case of breakage. President Blackall said his car inspectors were unanimously in favor of the tail bolt. Mr. Mendenhall said that west of the Alleghenies the railways seemed to be tending toward the use of the yoke fastening. Perhaps this was due to the longer trains hauled there. In his own experience the tail bolt had given satisfaction. Mr. Geo. L. Fowler said that in examining some 25 broken tail bolts (2¼ ins. diameter) he found that four-fifths broke directly under the head, and the metal was crystallized, indicating that it had been worked at too low a heat. Many failures of tail bolts are due to the heads pulling through. If there is no key back of the drawbar, the head will give a hammer-like blow on the end of the bar when the slack is taken out of the train and may break its way through. Of course a large number of breakages are due to the use of tail bolts too small to stand the strain.

The subject of spark arresters was then taken up, the discussion bearing on merits of diamond stacks and extension fronts as spark arresters. The general opinion seemed to be that the extension front was as good a spark arrester as existed at present. The amount of sparks which were collected in it was proof that it stopped part of the sparks at least. Probably no device would absolutely prevent the escape of sparks. Mr. Sinclair thought the American practice of choking the draft with netting and diaphragms was largely a relic of the days when wood was the standard locomotive fuel, and spark arresters were a necessity. The best place to have the sparks stay was in the firebox, and if the obstructions to the draft were done away with, the nozzle could be enlarged, the back pressure cut down and the draft made so light that the fire would not be pulled through the tubes.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on Feb. 4, Mr. John Birkinbine, President, in the chair, 40 members and visitors present, Dr. Henry Leffmann presented a paper on "The West Sterilizer for Water and Milk." He considered the application of heat the best method of sterilization. A temperature of 212° F. will accomplish this if long continued; higher temperatures (say 240° F.) produce very rapid destruction of all living organic matter. The employment of this method is, however, generally inconvenient and expensive. Moreover, if water be boiled in an open vessel, not only is it impossible to get the temperature above 212° F., but the dissolved gases are expelled, rendering the water flat and vapid, and in some natural waters much mineral matter is deposited. Boiling in closed vessel requires care, unless a perfectly automatic and continuous method be devised.

The West sterilizer is so constructed as to permit the continuous heating of water intended for drinking purposes to temperatures from 212° to 250° F., thus including temperatures amply sufficient to destroy all infection. The heating is done in a closed cylinder, provided with an automatic valve, by which water will not be permitted to pass to the storage chamber unless the proper temperature is maintained. If, by any change in the condition of the supply or source of heat, the temperature of the sterilizing chamber sinks below that at which the valve has been set, the valve closes and water ceases to flow. It is thus impossible to pass unsterilized water to the storage chamber. The automatic valve can be set at a desired temperature. The heating, taking place in an entirely closed vessel, does not deprive the water of its gases.

The president described a photograph of an engine built by the elder Stephens in 1804 and used in 1805, to propel a steamboat on the Hudson River. It was of the vertical type, with cross-head actuating, by connecting rods, two shafts, and forming a veritable twin-screw propeller. Mr. Falkenau announced that the first carrier had successfully passed through the automatic tubes connecting the post office at Ninth and Chestnut Sts., with the branch office on Chestnut St. below Fourth St., early in the evening.

L. F. Rondinella, Secy.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on Feb. 15, Mr. C. B. Brush, Vice-President, in the chair, the paper on "Controverted Questions in Road Construction," by Mr. Owen (Eng. News, Nov. 24, 1892), was discussed. Written discussions from E. Prince, J. F. Crowell, E. W. Howe, W. H. Grant and Latham Anderson, were read by the secretary. Mr. Prince thought that legislation for good roads should include provision for their maintenance, and Mr. Crowell advocated light rollers and a minimum grade of 2%. Mr. Howe stated that repairs should not be left until the road is all worn out, but should be kept in proper repair by constant renewals of stone in small quantities where needed. Mr. Grant referred to the construction of the roads in Central Park, which were designed for pleasure driving, and therefore were not laid out on the principles of roads for general traffic; he preferred heavy rolling. Mr. Anderson referred to the wide differences of conditions and materials in different sections of the country, and advocated a narrow central strip of gravel road, with a mud road left on each side, which would be in good condition for dry weather.

Mr. Oastler, agent for the Aveling & Porter steam roller, said he preferred to roll the subgrade level, and use larger stones in the middle of the telford foundation to give the crown to the road. He presented information from various cities showing a large preponderance of opinion in favor of the steam roller as compared with the horse roller. Mr. H. M. Wilson referred to the use of hydraulic limestone ("kunkur") for the roads in India, and the constant care of the native laborers in maintaining the roads, which has much to do with their excellent condition. Mr. Bacot, Engineer for the Staten Island roads, (Eng. News, Dec. 13, 1890), preferred 10 to 20-ton steam rollers; the New York road law specifies how the roads shall be built, and requires the use of rock dust for binding material, but he thought gravel preferable, while clay is good if used moderately, and never more than ½ in. thick.

Mr. Saabye pointed out that rolling might be carried so far as to crush the road and damage it; machine broken stone has the disadvantage of being somewhat rounded, and not so sharp and cubical as hand-broken stone. In Denmark, a state road built with granite and hard limestone had 4 ins. of 2½ to 2¾-in. stone, rolled with 10-ton horse rollers, then another similar layer, and a top dressing of 1 to 1½-in. stone. At Roanoke, Va., 6 to 9 ins. of stone are used. French engineers have decided that some kinds of limestone are suitable for road work. Mr. North said that roads built with trap and softer stone require different treatment. He also referred to the construction of the Central Park roads, and read a letter from Mr. Callahan, owner of a limestone quarry at South Bethlehem, Pa., claiming that certain qualities of hard limestone are well suited for road work, especially where trap is not available, and has given great satisfaction in practice. Mr. O'Rourke said that at Poughkeepsie, N. Y., some time ago, they covered every street with 8 ins. of stone and left the traffic to wear it down. Mr. Owen, in concluding the discussion, said that a road, like a railway track, should be built to take any load that may come upon it.

INSTITUTION OF MECHANICAL ENGINEERS (From our London correspondent).—The 46th annual meeting was held on Feb. 2 and 3, in the hall of the Institution of Civil Engineers, in London, under the chairmanship of Dr. William Anderson, the president. The report of the council showed a membership at the close of last year of 2,147, as compared with 2,077 at the end of the previous year. The first paper read was by Mr. R. Edmund Froude, of Haslar, entitled "Description of the Experimental Apparatus and Shaping Machine for Ship Models at the Admiralty Experiment Works, Haslar." The author pointed out that the principal feature at that establishment, as of the former one at Torquay, consisted in a long, covered waterway, in which models of ships are towed to ascertain their resistance. The towing is done from a dynamometer carriage driven at definite speeds by a stationary engine working a wire-rope. The models are made of hard paraffine, generally about 14 ft. long and upward of 1 in. in thickness as finished. They are cast in a mold, with an allowance of about ¼ in. for finishing accurately to shape, which is done by means of guidance grooves cut in the paraffine by a specially devised shaping machine. The waterway at Haslar is nearly 400 ft. long, and of nearly uniform section throughout. The sides are of concrete and vertical, instead of asphalted earth slopes, and the railway on which the dynamometer carriage runs is bedded on the tops of the side walls of the waterway instead of being suspended over the water from the roof. The railway is extended beyond one end of the waterway so that the experimental carriage can be brought over a dry pit for getting at the apparatus from beneath. The carriage, which has to span the whole width of the waterway, runs, therefore, on a railway of nearly 21-ft. gage. It is a trussed structure, and its chief peculiarity lies in the fact that the members of the several trusses composing it are wooden trunks or boxes, about 4 ins. square in cross section, made of ⅝-in. deal, and put together with screws and shellac varnish. The general design of the carriage is arranged so as to leave clear a sort of central alley provided with a railway. This secondary railway carries a smaller carriage on which is mounted the experimental apparatus so that the latter can be adjusted to any desired position fore and aft on the main carriage. The driving wire-rope is led over a grooved sheave, driven by the engine, which is a 10-in. Tower spherical engine. The

ordinary speeds of experiment range between 100 and 500 ft. per minute. For some classes of models the experiments are occasionally made up to 850 ft. a minute, or 9½ miles an hour. The truck has, however, been run at over 1,200 ft., or 14 miles an hour. The engine is regulated by a governor, acting on the same principle as that used at Torquay, and described in Mr. R. Gordon's paper, read in 1884, but is somewhat improved in detail.

The machine shaping of the model consists in cutting a series of grooves in the rough model, to the depth of the intended finishing surface, at the successive levels of the series of water lines in the half-breadth plan, the surface between the grooves being finished off by hand and eye. These grooves are cut by a pair of revolving cutters, between which the model passes, traveling in a fore and aft line, while the cutters are moved laterally, receding from and approaching each other symmetrically, in such accordance with the longitudinal travel of the model as to trace in plan upon it the intended horizontal section or water line. This due accordance of the lateral motion of the cutters with the longitudinal motion of the model is accomplished by the operator so regulating the cutter motion as to maintain a tracer in contact with the corresponding water line on the drawing. By means of suitable mechanism, the drawing itself is made to imitate the longitudinal travel of the model, while the tracer imitates the lateral travel of the cutters. The chief features of difference between the shaping machine at Haslar and that at Torquay are as follows: First, the adjustment of relative level of model and cutters requisite for cutting the successive water lines, is effected at Haslar by raising and lowering the cutters themselves instead of the model. The main advantage of this arrangement lies in a firmer vertical support for the model throughout its entire length. Secondly, the lateral motion of the cutters is controlled and made symmetrical by means of a right and left-handed screw, working in nuts fitted in the cutter frames, the screw being worked by miter gear from a hand wheel. Thirdly, the drawing table, besides being much larger than at Torquay, lies in a horizontal plane instead of standing in a vertical plane. The motion of the tracer is therefore horizontal and lateral, instead of vertical. The purpose of the much larger relative size of the drawing table, especially as regards its length, is to enable half-breadth plans of the usual scale of a quarter of an inch to a foot to be used for models of large ships. The use of so large a table requires special provisions for accuracy, which constitute a distinct feature in the Haslar machine. The method of communicating the proportionate longitudinal motion from the model table to the drawing table consists in the use of light change-wheels, of which the shafts take their motion off the model table and the drawing respectively, by stretched pianoforte wire winding on and off a drum on each shaft. The actual work done by the copying apparatus is simply that of sliding over a drawing a tracer consisting of a piece of tracing paper. Thus, the only material resistance to be overcome is the friction of the mechanism itself, and care was therefore taken in the design to use such mechanical features as give precision against small forces, but involve little friction. The fulcrum of the copying lever can be adjusted so as to give any desired proportion of travel of tracer to that of cutters; also the proportion of longitudinal travel of drawing table to that of model is regulated by change-wheels, and the "lost motion" due to play of teeth in these wheels is eliminated by a weight leading over a pulley, keeping a tension on the table always in one direction. The model table has a maximum longitudinal travel of 20 ft. Its travel is effected, not by a hand winch, as at Torquay, but by a simple quasi-hydraulic arrangement, the liquid used being paraffine oil instead of water in order not to rust the steel wire. The principal novelty of the arrangement is that the hydraulic pressure required, amounting to only 141 lbs. to the square inch, is maintained not by an accumulator or high level cistern, but by a little high-speed centrifugal pump driven by the cord belt which drives the cutters. This method is very convenient, and is found quite satisfactory in working. With regard to the melting and casting of the models, it has now been found better to coat the cores with a simple wash of clay without using any plaster of Paris. It has also been found best to cast models at a temperature not higher than 160° F., and that by mixing a little wax with the paraffine and by remelting it several times in buckets when newly bought, porousness of the castings is almost entirely done away with. A weighing machine is used for obtaining the dead weight of the models in order to determine the amount of ballast required, and a special machine has been constructed for that purpose.

The discussion on the paper was of no particular interest, but Mr. White, Constructor to the Admiralty, mentioned that the existence of the Haslar establishment had been of immense advantage, and had resulted in an enormous economy to the country. It had greatly helped in advancing the speed of war vessels and no pains were spared to obtain the closest accuracy. He stated that the Italian government had erected similar apparatus at Spezzia, and that the example was about to be followed by Russia and the United States.

Mr. Wm. Matthews then read a paper describing the pumping machinery and filtering plant of the Southampton water-works. Compound beam engines with fly-wheel are used, running at only 18 revs. per minute, and the pair of engines have a daily capacity of only 4,000,000 gallons. The steam pressure used is only 60 lbs. From the description given of the engines there appears to be nothing about them which could be copied with any profit by American pumping engine builders. The plant for softening the water is exceedingly interesting; but a full illustrated description has already been given by Engineering News (April 16, 1892). In the discussion it was stated that the life of the cloth used in the filters is from five to six months.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the meeting on Feb. 14 Mr. Herman read a paper on "A Weldless Chain." Oval link welded chain, as used in ship cables and for hoisting, is produced in almost the same manner as it has been for several centuries past. Few and but slight improvements have ever been introduced into this industry. Devices intended to supplant this class of chain have never succeeded, for all sacrifice the flexibility at every joint possessed by the ordinary chain. The new chain invented by the author of the paper consists of links, each formed of four separate parts—two side bars and two end pieces. The latter are provided with suitable threaded cavities to receive the screw ends of the former. The links so constructed possess the flexibility of the common chain to the fullest extent. Material and form of each part are selected with regard to the work they have to perform in practical use, while the proportions at each joint are determined by the most careful calculation. In this way a link is produced that fulfills all the theoretical and practical requirements of a perfect chain, and is at the same time free entirely from the uncertainty of the weld. The different sizes of this chain will be introduced by indicative numbers. These will convey full information as to strength, safe load and pitch of each size. The chain will be produced ready for use by means of automatic machines invented by the writer. Under the most trying tests this chain has proved its strength and reliability.

Chas. S. Howe, Secy.

ENGINEERING ASSOCIATION OF THE SOUTH.—The February meeting was held Feb. 9. President E. C. Lewis presiding.

Prof. Wm. T. Magruder, of Vanderbilt University, presented a paper on "Mechanics as a Fine Art." He showed that while the Greeks are our masters in many of the arts, yet in mechanics and physics their notions were far from correct, owing to a supposed variance between theory and practice. He pointed out how prejudice governed men's minds then as now, and that to move ships on dry land, to burn fleets by the concentration of the sun's rays, and the like, for the benefit of the state, were of less importance in the days of Archimedes than some geometrical abstraction. Clearly drawing the distinction between science and art, he showed, by example, how an art, to be a fine art, must minister not to the material necessities or conveniences of man, but to his love of beauty, and that the essence of all fine arts is the imagination, and that they cannot be produced or practiced by habit and calculation. The engineer or architect who starts to design a machine or structure scientifically must, of necessity, call the art of applied mechanics to his assistance. Having determined its outlines by a study of the requirements of the problem, having worked by calculation from the rules of the arts, the form, size and strength of its various parts, he has but completed the demands made upon him by a utilitarian age and the exigencies of business competition. To construct a building, erect a bridge or build a machine of such a design that, while it may be in accord with all the rules of the art, yet offends the eye, and does not appeal to our sense of beauty, at least by comparison, is to take a step backward in our civilization, to insult the taste of men of cultivation, and to lose an opportunity to expand one's own mind. His paper was a plea for the freer use of the imagination and of the beautiful in structures and machines.

Olin H. Landreth, Act. Secy.

MONTANA STATE IRRIGATION CONVENTION.—The second annual meeting was held at Helena, Feb. 9 to 11, principally to consider the bill before the present legislature involving the bonding of the state for the condemnation of existing irrigation canals, the construction of new ones and dividing the state into two irrigation districts, the dividing line being the main divide of the Rocky Mountains. The bill is said to have bad features and it was the sense of the convention that it should not pass, and they so recommended to the legislature.

The Montana State Irrigation Society was formed, with rules drawn up similar to those of the American Institute of Mining Engineers, applying to irrigation instead of mining. The officers elected were: President, J. M. Robinson, Bozeman; 1st. Vice-President, I. D. O'Donnell, Billings; 2d Vice-President, Chas. H. Wright, Great Falls; Secretary, S. B. Robbins, Great Falls; Treasurer, H. M. Parchen, Helena; and an executive committee of one from each county in the state.

It was decided to elect a committee of five engineers to report annually, or at the quarterly meetings if so directed by the executive committee, upon the state of irrigation, new works, etc. There were only two engineers members at the time of the meeting, so they were put on the committee, and also the following engineers conditional upon their election as members: C. W. Thorpe, Bozeman; H. A. Crowley, Boulder; J. M. Page, Twin Bridges. The ones elected were: J. W. Wade, Helena; S. B. Robbins, Great Falls. The next annual meeting will be held in Great Falls the second Thursday of January, 1894. S. B. Robbins, Secy.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—This society was organized in January, and at a meeting of the council of the society recently held in Washington the Committee on Organization reported that in reply to the invitations issued there had been received 408 requests to be entered as members and associates. The first general meeting will be held in New York about October, 1893. The officers of the society are as follows: President, Clement A. Griscom, Philadelphia, President of the International Navigation Co.; First Vice-President, Theodore D. Wilson, Washington, D. C., Chief Constructor U. S. Navy; Vice-Presidents, Charles H. Cramp, Philadelphia, President William Cramp & Sons' Ship & Engine Building Co.; George W. Melville, Washington, D. C., Engineer in Chief U. S. Navy; George W. Quintard, New York, President Quintard Iron Works; Irving M. Scott, San Francisco, Vice-President and General Manager Union Iron Works; Francis A. Walker, Boston, President Massachusetts Institute of Technology; William H. Webb, New York, naval architect (retired); Secretary and Treasurer, Washington L. Capps, Washington, D. C., Assistant Naval Constructor U. S. Navy.

COLUMBIAN ENGINEERING SOCIETY.—This society, of Washington, D. C., has elected the following officers: President, Francis R. Fava, Jr.; Vice-President, W. G. Steward; Secretary, F. W. Hart; Assistant Secretary, J. S. Pendleton; Financial Secretary, C. C. Jones; Librarian, W. H. Aspinwall; additional Members of Board of Direction, F. L. Averill, F. G. Perry and J. Meigs, Jr.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF ST. LOUIS.
March 1. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
March 1. Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF MINNEAPOLIS.
March 2. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
March 3. Secy., F. K. Smoot 808 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
March 3. Secy., O. Von Geldern, 719 Market St., San Francisco.
ENGINEERS' CLUB OF PHILADELPHIA.
March 4. 1122 Girard St. Secy., L. F. Rondinella.
MONTANA SOCIETY OF CIVIL ENGINEERS.
March 4. Secy., F. D. Jones, Helena.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
March 6. Secy., C. L. Annan, City Engineer's Office.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
March 7. Secy., Chas. S. Howe, Case School.
ENGINEERS' SOCIETY OF PHOENIXVILLE.
March 7. Secy., W. Halliburton.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
March 8. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
March 8. Secy., F. M. Curtis, O. C. R. R., Boston.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
March 9. Secy., F. W. Mowbray, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
March 9. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
March 10. Secy., D. W. Meeker, St. Paul.
WISCONSIN POLYTECHNIC SOCIETY.
March 18. Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
March 13. Secy., Waterman Stone, Baird Building.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
March 14. S. W. Spear, E. Buffalo, N. Y., Iron Works.
NORTHWESTERN SOCIETY OF ENGINEERS.
March 14. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
NORTHWEST RAILROAD CLUB.
March 14. Union Station, St. Paul. Secy., W. D. Crosman.
DENVER SOCIETY OF CIVIL ENGINEERS.
March 14. Secy., F. E. King, Jacobson Block.
BOSTON SOCIETY OF CIVIL ENGINEERS.
March 15. Secy., S. E. Tinkham, 36 Broomfield St.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
March 15. Annual meeting. Secy., J. E. Schick, Roanoke, Va.
NEW YORK RAILROAD CLUB.
March 16. Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
March 16. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
March 16. Secy., C. F. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
March 17. 901 Washington Building.
SWEDISH ENGINEERS' CLUB.
March 18. Secy., P. Valentine, At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ed son.
WESTERN RAILWAY CLUB.
March 21. Secy., C. F. Street, Rookery Building, Chicago.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
March 21. Secy., E. H. Clark, Pittsburg.
CENTRAL RAILWAY CLUB.
March 22. Secy., S. W. Spear, Buffalo, N. Y.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
March 24. Secy., C. H. McLeod, Montreal, P. Q.
WESTERN SOCIETY OF ENGINEERS.
April 5. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 20. Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.

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The competitive tests of the Westinghouse and New York air brakes made last September on the New York Central R. R. near Albany are reported elsewhere in this issue. The tests were doubtless the most accurate and thorough air brake tests which have ever been made, and the records deserve careful study. The only official statement of the results of the tests which has thus far appeared is a public statement by the Third Vice-President of the New York Central that the two brakes showed no difference of practical importance in their operating efficiency. From the report of the tests given in another column, our readers will be enabled to form their own judgment on this matter. We may sum up the results of most importance in a few words. The New York brake, which in the tests on the Chicago, Burlington & Quincy and Lehigh Valley, made a year ago, gave great trouble by sticking on and refusing to release, was released without difficulty in the New York Central tests. In remedying this difficulty, however, a worse one seems to have been encountered. The rate of application of the brakes has been so reduced that severe shocks were experienced in the rear car in all the emergency tests. The shocks, as measured by the slidometer movement, were very uniform, and averaged 28 ins. The importance of this may best be understood by recalling the Burlington brake trials of 1886-7, where it was decided that no brake applied by air pressure could be made a practical success, on account of the severe shocks experienced. Not until Mr. Westinghouse perfected his quick-action triple valve, and so accelerated the rate of application of the brakes that they went on from the front to the rear of the train faster than the shock could travel back, was the compressed air brake accepted as available for general use in freight service.

The reason why shocks occurred with the New York brake is well shown by the automatic diagrams taken in the standing test. These showed that while with the Westinghouse brake 2.43 seconds elapsed between the entrance of air to the brake cylinder of the 1st car and the entrance to the cylinder of the 50th car, with the New York brake 2.92 seconds was required for the same operation. This is a difference of 0.49 seconds, and experience has amply proved that this difference in time of application can make a great difference in the shocks.

If the Third Vice-President of the New York Central, or any other railway officer, considers that a shock which causes a slidometer movement of 28 ins. is of no practical importance in railway operation, he should ride in the rear car of a 50-car train and cling to the car sides while he watches the slidometer make a 28-in. dash. According to the exhaustive report of the M. C. B. committee on the Burlington brake tests of 1886-7, a shock which causes a 12-in. slidometer movement is sufficient to be injurious to live stock and equipment, and repeated shocks of 12 to 20 ins. were sufficient to start the loads at the rear of a 50-car train through the ends of the cars. We postpone further comment on the results of the tests, to a following issue.

The collapse of what is known as the Reading Syndicate, whose operations have been the principal theme of discussion in the railway world since last February, has come, and receivers have been appointed to the control of that vast property. The formation of the anthracite coal combination by the lease a year ago of the Lehigh Valley system and the Central R. R., of New Jersey, and the later negotiations by which control was secured of the output of private miners and the smaller coal roads, thus obtaining control of 75% of the anthracite coal output and effecting the largest coal combination on record, and finally by the lease of the Boston & Maine system of railways, is well known. The causes which have worked to the downfall of the combination are various. Opposition was developed from the first; not only that of rival interests, but that of the state judiciaries and legislatures, and each succeeding move of the combination has increased this antagonism. By this the foundation of the combination was rendered insecure, and when the time was opportune, powerful and compact rival interests crushed it and secured the properties almost at their own prices. It is too early yet to know with certainty into whose hands the control has passed. The indications are, however, that the Drexels, who originally reorganized the Reading interests, are again in possession. The rumor is that the respective interests headed by Mr. McLeod, the President of the Reading system, and the Drexels have been antagonistic for some time, and that this antagonism was brought to an acute stage by the incursion of the former into New England. The trouble seems to have been the old one which has overthrown so many strong combinations; the system spread itself too widely and was bound together too loosely in the face of compact and vigilant opposing interests. It is not to be assumed, however, that the appointment of receivers necessarily means the resolution at once of the Reading system into its component parts. In fact, the appointment of receivers goes to show the contrary, but it is too early to speculate with much certainty upon the future of the combination. One thing is plain, however, and that is that a bankrupt road is a very insecure foundation upon which to build a great system of railways.

The three days' steady assault, which resulted in the collapse of the Reading combination, will be memorable in the history of the stock market as a period of enormous transactions and of the continued liquidations and heavy decline in price of a single leading speculative stock. In few instances is the well-worn quotation "rose like a rocket, fell like the stick" more apt than in describing the history of this stock during the past 12 months. Just about a year ago the market was electrified by trading on a gigantic scale in "Reading," which carried it up to 65, followed by the announcement of the formation of a great coal combination. On Feb. 11, 1892, the total sales amounted to 565,685 shares, the largest on record. From 65 the stock gradually declined, with occasional advances as new deals were made known, until on Feb. 16, last, it reached 47, with a sale of 45,700 shares. On Feb. 17 the assault on the stock began and it closed at 40⅞, with a sale of 390,630 shares. The two hours of Feb. 18 (Saturday) saw a sale of 514,110 shares, and a further fall to 36¾, and on Feb. 19 the liquidation was continued with a sale of 952,265 shares and a decline in price to 28½ for the lowest and a closing price of 30. The total sales for the two days and a half were thus 2,057,000, or considerably more than the total capital stock of the Reading company twice over. Of course, the bulk of this represents speculative transactions pure and simple, as sufficient shares were traded in during the first two days to transfer the control of the company to new hands. Such extensive liquidation has, of course, caused enormous financial losses; the price of Reading stock having fallen $8,000,000 within a week, not to mention a similar loss in New York & New England stock held by the syndicate.

THE USE OF SEWAGE FOR IRRIGATION IN THE WEST.

Considering the general development of the two sections of the country, the western part of the United States has been more forward in the purification of sewage than the eastern. This is accounted for in three ways: (1) The very low stage of western streams during the hot dry season, often renders sewage discharged into them an unbearable nuisance, or there may be no natural stream near by of sufficient size to receive sewage. (2) The familiarity of the people with irrigation, and (3) the value of all available water for this purpose naturally leads to the application of sewage to crops when any method of purification is necessary.

For the above reasons all but two of the sewage purification plants west of the Mississippi River employ irrigation, and one of the two exceptions, Hastings, Neb., uses intermittent filtration and will probably raise crops eventually, while the other, Leadville, Colo., only strains the sewage through a small area of sand.

As shown elsewhere in this issue, eight of our western towns are prepared to apply sewage to land for irrigation in the season of 1893. In addition, Los Angeles may also be ready to so dispose of its sewage in 1893, and until three years ago had been so doing for some time, while at Cheyenne, Wyo., sewage was for seven or eight years delivered into an irrigating ditch and used for irrigation, this use being stopped only by a change in the outlet sewer.

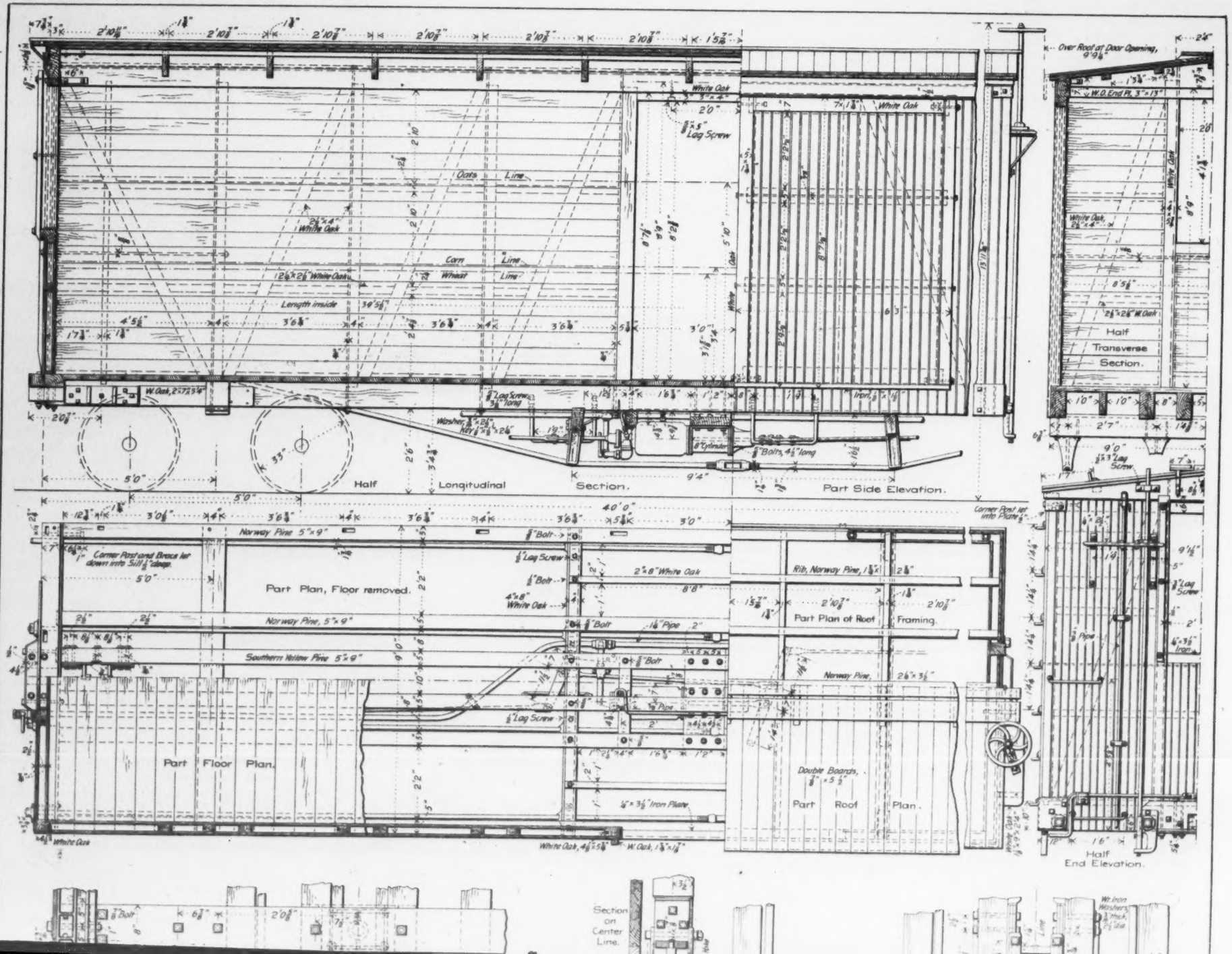
Some of the leading points regarding these sewage farms are given in the accompanying table, from which it appears that sewage was first used for irrigation at Cheyenne, Wyo., probably in 1883. It is not certain when the sewage of Los Angeles was first applied to land, the information at hand referring to the "boom" period as a time when the use of sewage began to be discontinued on account of cutting up the sewage irrigated land into building lots.

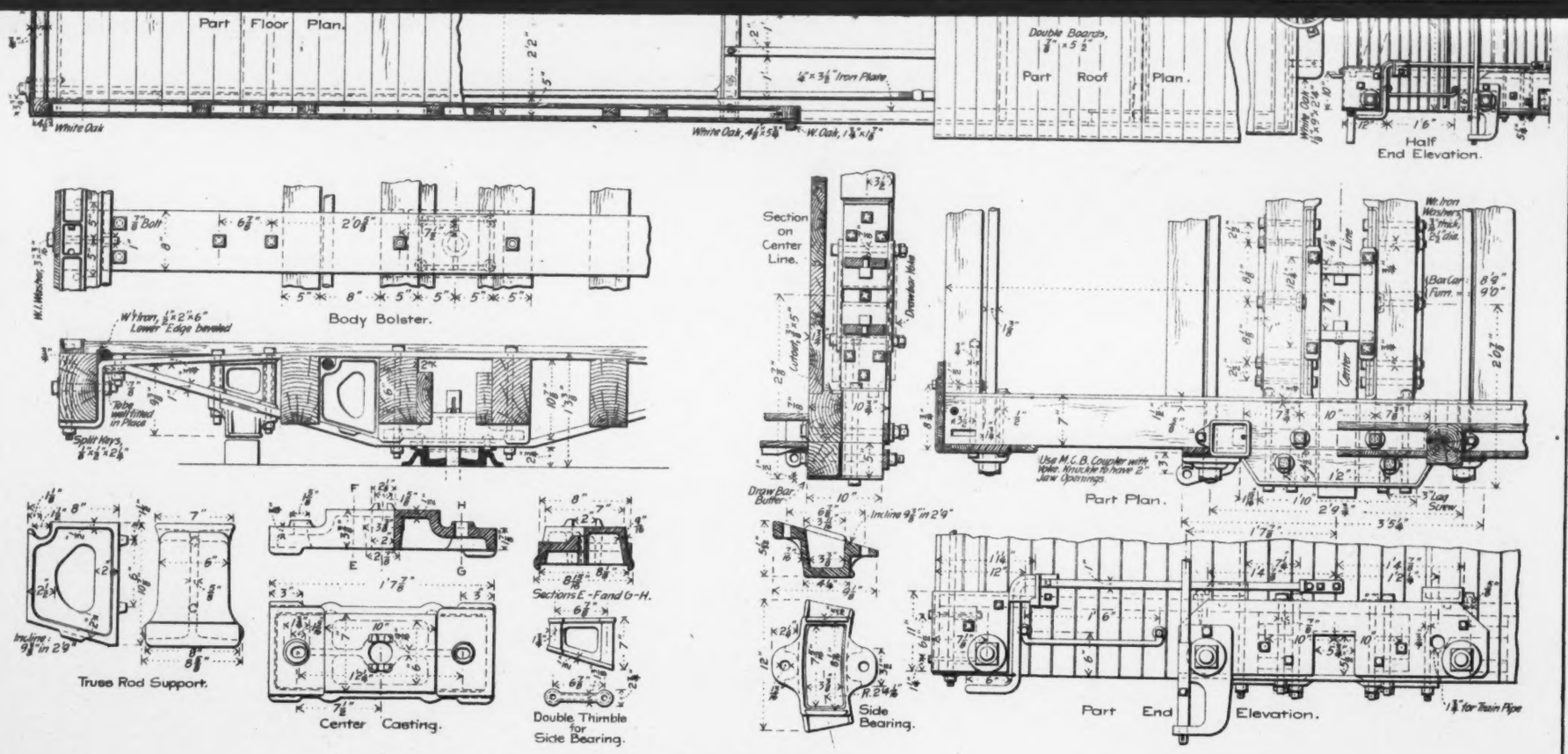
At Cheyenne, Los Angeles and Stockton it seems that the primary cause for the application of sewage to land was to save the water for irrigation; at Colorado Springs and Santa Rosa the pollution of streams by sewage led to lawsuits, and finally to sewage disposal on land; while at the other localities the avoidance of stream pollution or the lack of streams into which sewage could be discharged seems to have been the ruling cause, unless it be at Helena, where the formation of a park was a partial or the sole motive.

Pasadena, Santa Rosa and Helena are the only three cities of the ten in the list that have bought land for a sewage farm, and Pasadena is the only city of the three that has not rented the farms bought. Four of the cities, Colorado Springs, Trinidad, Fresno and Redding, pay the private parties who receive the sewage for disposing of it. Information on this point regarding Stockton is not at hand, but at all the other cities where private parties own the sewage farms no rental is, or has been, paid on either side, but Los Angeles proposes to furnish sewage to land along its outlet sewer at a fixed price per acre, $3 being mentioned as the probable rental.

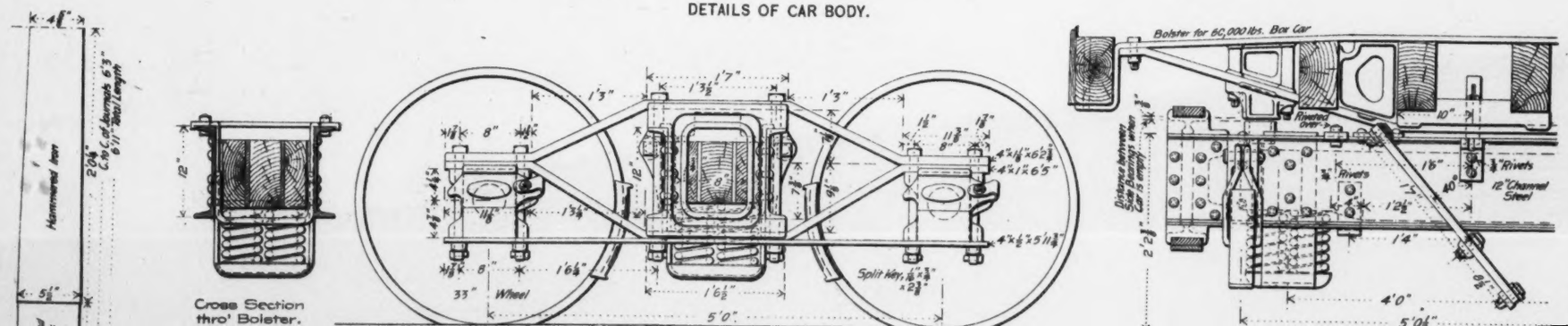
Of the two city-owned farms already in use Santa Rosa leases its farm, receiving in return the care of the farm and the disposal of the sewage. At Helena the lessee plants 100 trees, and makes one acre of lawn each year, pays some cash and cares for the improved land, in return for which he has the use of the remaining portion of the tract.

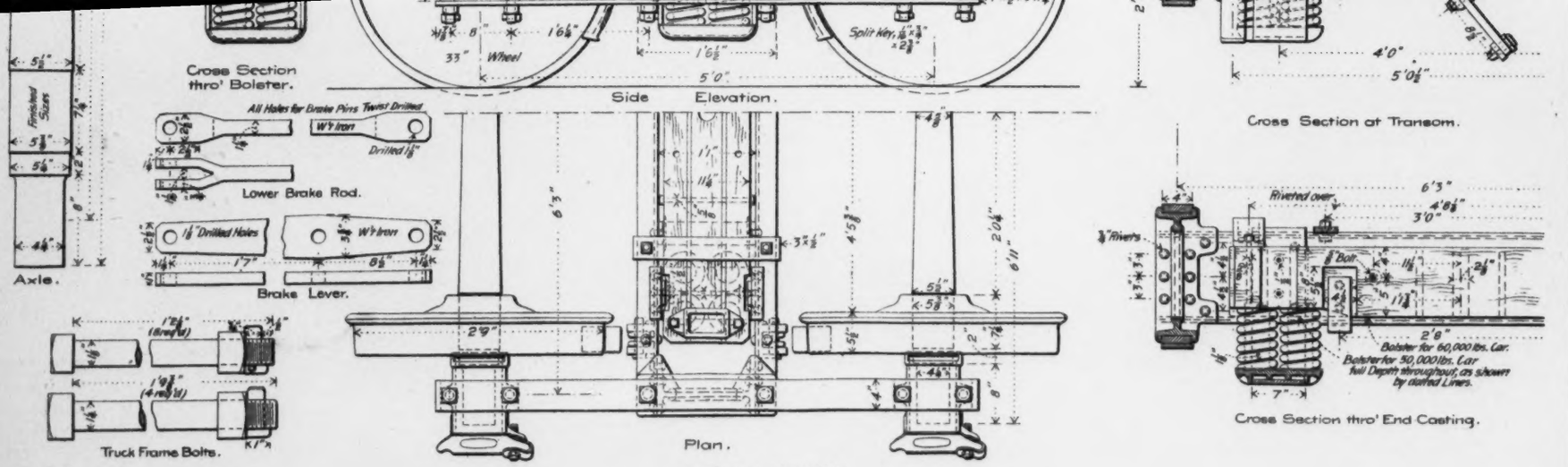
Redding is not only one of the smallest towns in the United States which employs sewage purification, but is also one of the smallest having a sewerage system, its population in 1890 having been only 1,821. On the other hand, Los Angeles, with a population of 50,395 in 1890, is the next


Half Longitudinal Section.
Part Side Elevation.
Half Transverse Section.
Part Plan, Floor removed.
Part Floor Plan.
Part Plan of Roof Framing.
Part Roof Plan.
Half End Elevation.
Section on Center Line.
Oats Line
Corn Line
Wheat Line
Length inside 36'5½"
Norway Pine 5"×9"
Southern Yellow Pine 5"×9"
White Oak
Rib, Norway Pine, 1½"×2½"
Double Boards, ⅞"×5½"
Over Roof at Door Opening, 9'9½"
Half Transverse Section.



DETAILS OF CAR BODY.





DETAILS OF TRUCK.

STANDARD 50,000-lb. FURNITURE CAR; CHICAGO, BURLINGTON & QUINCY R. R.

G. W. Rhodes, Superintendent of Motive Power.

CHAS. HART & SONS, LITH, 14 VESEY ST., N. Y.

to the largest city in the United States which has yet purified or utilized its sewage, Worcester, with a population of 84,655 in 1890, purifying a part of its sewage by chemical precipitation, as described in Engineering News of Nov. 15, 1890, and July 28, 1892.

As to crops raised there is no uniformity of practice; nearly every variety of garden stuff seems to have been tried, and in addition fruit, nursery stock, alfalfa and hay. At Trinidad the owner of the farm proposes to raise blue grass, as he thinks this will stand more irrigation than any other crop, while for the same reason alfalfa is favored for a future crop at Pasadena.

It is interesting and amusing to note that at Colorado Springs, where a sewage farm was made necessary by a lawsuit brought by a ranchman on a stream below the old sewer outlet, the ranchmen on this same stream have since been complaining because the sewage is now diverted from the stream, evidently because of jealousy caused by seeing that the man who contracted to dispose of the sewage has water for irrigation when they have none. At Redding, Cal., the owner of the sewage farm was arrested at the instigation of an adjoining property owner, on the alleged ground of maintaining a nuisance, but the magistrate dismissed the arrested man.

In general, so far as reported, the sewage farms have not given offense, except at Los Angeles, where the sewage irrigated tract was finally divided into building lots, and the available land so restricted that sewage had to be discharged upon it when not needed. The company which received the sewage was finally compelled, in the courts, to keep it off from the greater part of the land, which necessitated discharge into the river, and led up to the building of the outfall sewer mentioned below, all of which is described in more detail elsewhere in this issue.

The future of sewage irrigation at Los Angeles seems promising, since the new outfall sewer planned for completion in July, 1893, extends for 12 miles to the Pacific Ocean, commanding some 20,000 acres of irrigable land, otherwise, we understand, without water. It is reported that the owners of one-half of this land already intend to buy sewage from the city. The outfall sewer has been located to command as much land as possible, with provisions for drawing out sewage similar to those made for drawing water from an irrigation pipe or ditch.

The Los Angeles sewage, when not needed for irrigation, will be discharged directly into the ocean, which makes over-irrigation entirely unnecessary, as well as any provision for purifying the sewage when not needed by the crops. A similar arrangement is provided at Stockton, the outlet sewer to the river being about two miles long.

Where a slight amount of storage can be provided without creating a nuisance, and at least one day's sewage could generally or always be so stored, it is advantageous to do so, for by this means sewage may sometimes be saved which would otherwise go to waste or be misapplied, and, in addition, all the sewage can be applied to the land in the daytime if desired. At Redding, provision has been made for one day's storage, and at Trinidad there is already available one small storage tank, and more tanks may be added.

Where domestic water supplies are not affected it is evident that sewage purification is most needed in the summer time, when the sewage flow is largest, the streams the lowest and, in the West, very fortunately, water for irrigation in great demand. This combination of circumstances favors sewage farming in the West, and seems likely to lead to the adoption of this mode of purification in many other Western towns. In several instances the farmers seem to have doubted the practicability of applying sewage to crops, but upon trial they and their neighbors have become convinced of both the practicability and value of the process. There seems to be reason for believing that with good management many of our Western cities can materially reduce the cost of desired sewage purification systems by utilizing the sewage for irrigation. Oftentimes such utilization would either render long outfall sewers unnecessary, or, where these pass through irrigable country, the sewage could be sold, as is proposed at Los Angeles. As we have previously suggested, this latter possibility is also worthy of consideration in the East, wherever outfall sewers could be made to serve cultivated or pasture lands. Where sewage purification is necessary, it should always be placed before revenue, and as yet no profit-making method of sewage purification has been devised, nor is one likely to be soon; but the expense of sewage purification, at least in arid or semi-arid regions, can certainly be materially lessened by using the sewage for irrigation. The subject is well worth study, for the common mode of sewage disposal by discharging it into streams, often those used for public water supplies, cannot and will not always be tolerated. Massachusetts and a few other states are already protesting against the practice, and others will follow, let us hope with rapidity.

General Information Regarding the Use of Sewage for Irrigation in the West.

	Population, 1890.	Ready for use.	Irrigation adopted on account of—	Ownership of irrigated land.	Rental.	Crops raised or proposed.
Colorado Springs, Colo.	11,140	1889	Lawsuit, account of pollution	Private	$300[1] per year, 5 years	Alfalfa, hay, garden truck
Trinidad, Colo.	5,523	Fall 1892	To prevent pollution of water used for domestic purposes	"	$500[1] "	Blue grass proposed
Fresno, Cal.	10,818	Jan., 1890	Best av'l'ble method	"	$5,000[1]	Chinese truck gardens
Pasadena, Cal.	4,882	1893	Evidently some purification necessary	City		B'ry, hay, fruit, veg'l'bles proposed
Redding, Cal.	1,821	1888	To prevent pollution Sacramento water supply	Private	$300[1] first year, and yearly increase[2]	Grain, potatoes, vegetables, fruit
Los Angeles, Cal.	50,395	Prior 1887	To provide water for irrigation.	"	No rental formerly[3]	Probably garden truck
Santa Rosa, Cal.	5,220	1889 or earlier.	Lawsuit, account of pollution	City	Leased without rental	Garden truck
Helena, Mont.	13,834	1889	Means of providing park	"	Leased; lessee makes improvements and cash payment	Vegetables, nursery stock
Cheyenne, Wyo.	11,690	Prob. 1893.	To provide water for irrigation	Private	No rental.	
Stockton, Cal.	14,424	1892 or 1893	To provide water for irrigation	"		

[1] Paid by the city. [2] Increase yearly proportionately with assessment roll. [3] City may charge $3 per acre for land covered by new outfall.

LETTERS TO THE EDITOR.

CONTINUOUS RAILS.

Sir: Your issue of Feb. 2, 1893, contains a letter making such a sweeping assertion that continuous rails are a failure, that I feel called upon to lay aside my objection to rushing into print, and take up the cudgel in defence of my statement.

Your issue of Jan. 12, 1893, quoting from letters of mine to Mr. Jno. C. Trautwine, Jr., gives a fair idea of the experiment that Mr. Churchill so generally condemns and quickly lays aside.

This track, three miles long, was laid in June, 1889, on a new earthen roadway, and was surfaced with a clayey soil from adjacent cuts. About 300 ft. of the distance was in wet clay cuts, full of springs, and so soft that a horse could not be ridden through them. For the first year and a half of its service I watched the track closely. The only change in its surface was due to settlement of the embankments, which sags have never been taken out. Its alinement was practically perfect, and it was a favorite reach for trains to make up a few minutes of lost time. During this period of 18 months the maintenance of this track did not cost a penny, while for the same period there was expended $1,800 in labor for keeping either of the adjoining three-mile sections in fair condition.

Mr. Churchill's sweeping condemnation recalls a scene that once occurred in my office: An ingenious farmer had conceived what he hoped and thought to be a radical improvement in mowing machines. He embodied his idea in a crude wooden model, and submitted it to me for an opinion. After a careful examination I pushed it aside and said, "My friend, I don't think your machine will work." Quick as light, he replied, "Great Scott, stranger; you don't think I'd try to cut grass with a wooden knife! 'Hits the motion I'm seeking." So I am afraid, in a cursory examination, Mr. C. has seen the crude fastenings, rotten ties and earthen ballast, and lost sight of the "motion" sought.

I certainly would never attempt to put up first class track with light rails and wooden ties imbedded in earth; nor am I prepared to say that in continuous rails lies the whole secret of permanent way, but I feel convinced that with a firm roadbed, steel ties and good ballast, continuous rails, laid similarly to those in my experiment, will give an approximation to permanent way that will materially reduce the maintenance of way account, and rejoice the hearts of railway security holders.

Out of the old "grasshopper" locomotive and its "coaches" grew our magnificent equipment of to-day. Out of the strap rail grew the T, and there track evolution practically stopped. Heavy rails and plenty of ballast are undoubtedly good. So, also, are the 60-ft. rails that are now being used; but why be content with the old lip spike and joints every 60 ft.? I believe that I can demonstrate to anyone's satisfaction that continuous rails will relieve ties from that pounding on their beds that is so destructive to surface; but as to the exact length in which these rails should be laid, that is a matter for convenience and future experiment to determine. Surely any device that maintains surface and line on new earthen track for 1½ years (my experimental track has now been in service nearly four years) without labor, deserves careful consideration.

R. Taylor Gleaves.
Ex. Ch. Engr., L. & D. Ry.

Lynchburg, Va., Feb. 7, 1893.

(Our correspondent makes a strong plea. It is perfectly true that it is easy to be hypercritical in considering first experiments, and the very wording of the condemnatory opinions published by us Feb. 2 shows that the test track was laid under extremely severe conditions. Believing, as we do, that the principle of continuous rails is one of no little promise, fully deserving careful and patient test, we shall have great pleasure in making the further results from the present or any other such experiments as widely known as possible, and trust that we shall be favored with fuller records of actual experience with the continuous rails from time to time.—Ed.)

THE DELANO RAIL JOINT; CHICAGO, BURLINGTON & QUINCY R. R.

Sir: I note in Engineering News of Feb. 2, the publication of the matter regarding the experimental rail joint which we have always known on the road as the "pattern F. joint." There is one error in the article, namely, where it is stated that the joint has been in use nearly two years; in point of fact, it was put in track early in the spring of 1890—in April, I think—and has, therefore, been in use nearly three years.

I agree entirely with you that the progress made in the subject of rail joints is slow, and one reason is that a great many joints, which were expected to prove a great improvement over the angle bar joints, have not so developed; and another reason is that by means of a higher rail it has been possible to make a good deal better angle bar joint than it was with the old-fashioned low rail. I believe thoroughly in the support given to the rail by the angle bar. It is true that it may be laughed at as a "corset-like" kind of a fastening, but if it could be preserved in its integrity from the day it was first put on until the rail was worn out, I should say most decidedly that it was the best form of joint. It supports the rail more nearly at the neutral axis than any other rail joint can, and hence it follows that it interferes less with the wave motion under an approaching train than any other joint. Where the angle bar is faulty is that as soon as it begins to get nicked and bent at the joint, it deteriorates very rapidly, and from that time on nothing can ever restore it to its pristine condition.

That is my only reason for wishing to use a sub-plate, and my idea is that this sub-plate should not be very stiff and inflexible, and in any way in the nature of an anvil, but simply that it should be somewhat in the nature of a long washer, which in having the two ends of the rail clamped securely to it through the angle bar by means of the bolts, will prevent any independent movement of those rail ends, and make them act together more as they should; that is to say, as a hinge. I would for that reason not feel like accepting the suggestion that is offered in the article, namely, of stiffening the sub-plates by a rib on

the underside, for I think the sub-plate is stiff enough, and I think an under rib would be objectionable.

As to the requirements of joints for main tracks and in yards, I think that a joint which will stand up under switching service will stand up anywhere.

Yours truly,

Chicago, Ill., Feb. 8, 1893. F. A. Delano.

(We recognize fully the strength of Mr. Delano's argument for supporting the rail ends as by a hinge, as pointed out in our issue of Dec. 28, 1882. In Holley and Colburn's book on railway track, published in 1858, when only the low rail was in use in this country, it was stated that the fish plate joints had many defects, and could never be made satisfactory for American railways. The wedge and chair type of joint, with a long wedge bearing against the under side of the rail head, was recommended, and a form of angle bar joint was also favorably spoken of, which supported the rail by the head, and had the flanges of the bars spiked or bolted to the ties. The Patterson wedge joint (Eng. News, Feb. 21, 1891,) is being tried on the New York Central R. R., and is said to be giving very satisfactory results, but in this joint the wedge does not bear against the head of the rail. The adoption of the high rail has made the fish joint applicable without undue weakening of the rails, and this joint, or rater its development, the angle bar joint, is now practically the standard type of joint now used in this country, showing that it is unsafe, even for such shrewd and experienced men as Holley certainly was, to undertake the art of prophecy. It seems probable, however, that this type of joint will be very generally improved by the addition of some form of base support to keep the rail ends in proper line. As to the wear of the tops of the splice bars, on some English roads iron washers are placed under the rail heads, just at the joint itself, and there is a patented device for the use of a separate and renewable bearing plate between the rail head and splice bar. A smooth and even bearing, with ample width and surface, is requisite for an efficient and durable joint.—Ed.)

THE AUSTIN DAM CONTROVERSY.

Sir: In your issue of Jan. 12 you publish a telegram from J. T. Fanning, denying or attempting to deny the authorship of the diagram published in the same issue, saying: "The drawing," etc., "was not used by me." "I do not remember to have seen the drawing from which it was reproduced." Your comments seemed to imply an expectation that he would furnish the diagram which he did use and which he referred to in in his report.

The grain of truth in Fanning's assertion is this: The several lines in the diagram used by him were not

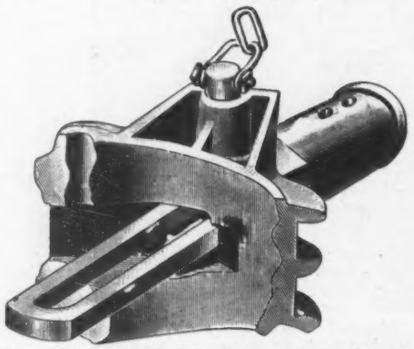


Fig. 2. Emergency Link Moved Forward for Use with Broken Head.

all drawn on the same sheet. Those representing the flow of water were on tracing cloth, the section of the dam on opaque paper. The two were adjusted to form the exact diagram published in the News, and to my distinct recollection were so exhibited when Fanning read his report to the Board.

In evidence of this fact I have received permission from Mr. N. Werinskiold, of Austin, Tex., Chief Assistant on the works, to publish a letter of his of 21st ult. I inclose a copy, and would request you to publish it side by side with Mr. Fanning's telegram to you of Jan. 10, published in your issue of Jan. 12. Comments, I believe, are unnecessary. At least, I have no desire to make any, except to say that my recollection exactly corresponds with that of Mr. Werinskiold.

Yours very truly,

Boston, Mass., Feb. 13, 1893. Jos. P. Frizell.

J. P. Frizell, Civil Engineer,
60 Congress St., Boston, Mass.

Dear Sir: Yours of 17 inst. just at hand. In reference to the diagrams I desire to say that blue print dated June 2, 1892, of the tracing used by Mr. Fanning was sent you among other prints of his plans. Shortly afterward Secretary Oliphant received your letter asking for the diagram showing how the flow might act destructively on the dam. I requested him to say that Mr. Fanning represented this by sliding his tracing over your section; that Mr. Fanning had taken the tracing home with him, but that I could reproduce diagrams showing the flow over your section, as represented by Mr. Fanning, if necessary.

On Aug. 19 I made such diagrams with explanatory notation, and I also made a notation of the high water level, as I deemed that of too much importance to be overlooked. The other diagram on the same blue print was similar to that dated June 2; but, for better explanation, I sketched in how it was expected the

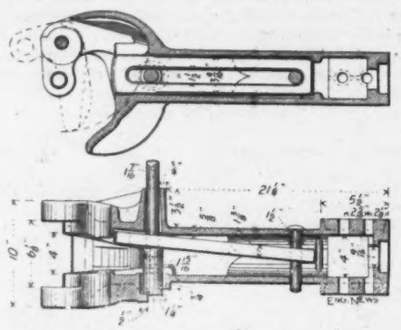


Fig. 1. Brown's Emergency Link Car Coupler, Horizontal and Vertical Sections.

water would follow the amended section and not the assumed theoretical line, owing to the atmospheric pressure or vacuum. You wrote the Secretary to get me to reproduce the diagram, and blue print of this, dated Aug. 19, was sent you. I, myself, saw Mr. Fanning represent the flow over your section by placing his tracing over same, as diagram dated Aug. 19 shows, and that before individual members (or at least member) of the Board; and I presume you saw it done before the Board.

Very respectfully yours,

N. Werinskiold.

(It is appropriate to state in this connection that we have not received from Mr. Fanning the statement or explanation which his telegram implied that he was preparing, or had prepared. The telegram referred to in the letter was as follows, the "proofs" mentioned being proofs of a letter which appeared in the same issue headed "What Is the American Society of Civil Engineers Going to Do About it?"—Ed.)

"Proof just received. I have wired the signers that the proof makes assertions which are untrue, and that

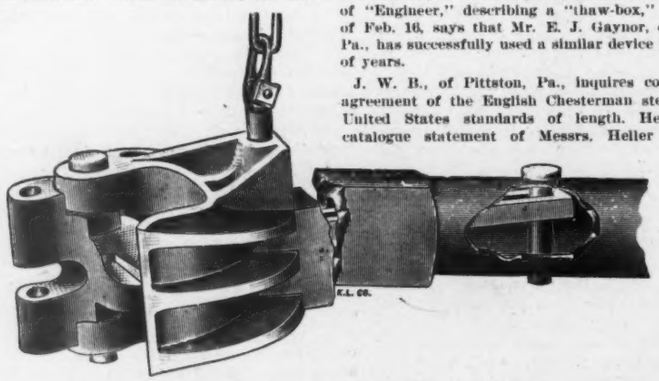


FIG. 3. EMERGENCY LINK HOLDING HEAD BROKEN AT SHANK FROM FALLING ON THE TRACK.

they have evidently been deceived. The drawing which you published Sept. 29 last was not used by me, and I do not remember having seen the drawing from which it was reproduced. A sketch, similar in part, was used and explained verbally to the Board." J. T. Fanning.

RADIUS OF GYRATION FORMULAS.—CORRECTION.

Sir: The article on "Radius of Gyration of Hollow Round and Square Columns," appearing in your issue of Feb. 2, contained one slight typographical error and one omission.

In the formula for G for cylindrical columns the expression $\sqrt{D^2 + d^2}$ should be preceded by the sign $= \frac{}{4}$.

Also equation (6) should read $X^2 - y^2 = .7854\ (61 - 49) = 11.781$.

Jackson, Mich., Feb. 14, 1893. Benj. F. LaRue.

SALT ON BRICK PAVEMENTS.

Sir: Our city fathers are very much troubled because the managers of our electric street railway are using salt on their track to keep it free from snow and ice. They fear that the brick paved streets will be damaged by the use of the salt. I do not remember having seen anything on the subject in Engineering News. If you think the matter of interest to the public will you kindly give the desired information as to whether the use of salt on brick paved streets is injurious to the pavement?

Very respectfully,

Jarvis S. Humphrey,
City Engineer.

Findlay, O., Feb. 14, 1893.

(According to our understanding and belief, the city fathers are borrowing trouble quite unnecessarily.—Ed.)

THE DUNNINGS' DAM.

Sir: In your last number we note a communication from Mr. E. Sherman Gould, M. Am. Soc. C. E., etc., which he states he wrote "the day after" receiving a pamphlet of this company, and in which he rather hastily makes certain allegations as to false statements contained in such pamphlet. While in point of fact there is no wish on the part of this company in any of its trade publications, to do any injustice to Mr. Gould, or any other engineer of his distinguished standing, we feel sure that had Mr. Gould waited another day, he probably would not have written as he did.

The dam in question was built by the Scranton Gas & Water Co., and the correspondence between this company and that corporation was conducted on the part of the latter company upon paper of the "Scranton Gas & Water Co." bearing the name of "Robert Reeves, Supt. and Engr." On the other hand, our letters from Mr. Gould in the same connection were on blank sheets and signed "E. Sherman Gould," without title whatever. Therefore while no doubt all that Mr. Gould states is perfectly true, it is a little hard to accuse our company of "false statements" in a matter where, in its desire to do what it thought was absolutely fair to all the parties, it mentioned in its illustration of the dams, both Mr. Reeves, who bears the title of "Supt. and Engr." of the "Scranton Gas & Water Co.," and Mr. Gould, whom we knew was in charge of the dam in question, though of course, we had no knowledge of the actual relations existing between himself and the Scranton Gas & Water Co. as to this particular work, and his exclusive control of the same.

Respectfully, American Cement Co.

Philadelphia, Feb. 11, 1893.

NOTES AND QUERIES.

J. W. K. asks where he can obtain plans for a dynamometer attachment to a car, to be used for measuring the drawbar pull of locomotives under various conditions; also the approximate cost of this appliance.

W. G. M., of Lebanon, Pa., in answer to the letter of "Engineer," describing a "thaw-box," in our issue of Feb. 16, says that Mr. E. J. Gaynor, of Pottsville, Pa., has successfully used a similar device for a number of years.

J. W. B., of Pittston, Pa., inquires concerning the agreement of the English Chesterman steel tape with United States standards of length. He quotes the catalogue statement of Messrs. Heller & Brightly,

edition of 1878, to the effect that that firm had found the English steel tape too short by ½ in. in a 100 ft., as compared with the U. S. standard. Our correspondent says he can find no difference between the Chesterman tape, in length, and the Excelsior tape sold by Keuffel & Esser Co., and claimed to be made to the U. S. standard. What is the experience of others in this connection?—Ed.

BROWN'S "EMERGENCY LINK" M. C. B. COUPLER.

It is difficult to find anything new under the sun in M. C. B. couplers, but the inventor of the coupler illustrated seems to have hit on a novel idea with at least enough apparent merit to justify its examination by railway officers. As seen by the

drawings, a forged link is placed in the cored hollow of the drawbar shank, and its end forms a lock against which the tail of the knuckle rests when it is closed. This link is secured by two pins, one through the shank of the coupler, the other through the head. If the knuckle or the jaws of the coupler break, as shown in Fig. 2, the link is moved forward by simply pulling the rear pin, and the train is coupled up at once, without the delay of a journey of half a train length forward to the engine or back to the caboose, which is the least consequence of such a breakage, or the necessity for chaining together the cars, which sometimes happens when the knuckle breaks so that it will not hold a pin. If the whole head breaks off the shank, moreover, as in Fig. 3, the link prevents the head from falling on the track. Fig. 1 shows horizontal and vertical sections of the coupler. The bar is made of malleable iron or steel, as desired; the knuckle is of cast steel and the link and its pins are of drop forged steel. This coupler is put on the market by the Brown's M. C. B. Emergency Link Car Coupler Co., Monadnock Building, Chicago.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 165.)

The Use of Sewage for Irrigation in the West.

The sewage purification plants described below are all located in the arid or semi-arid portion of the United States, where ordinary irrigation is practiced, and therefore it is but natural that sewage purification should be employed in connection with them. Moreover, with the exception of the plant at Hastings, Neb., where intermittent filtration is used with broad irrigation as an adjunct, and Leadville, Colo., where the sewage is filtered through a small area of sand, these ten sewage purification plants are the only ones yet constructed west of the Mississippi River, or, for that matter, west of Chicago, so far as we have been able to learn. A summary of the information presented below, with comments, is presented in the editorial columns of this issue.

Colorado Springs, Colo.

Colorado Springs adopted the method of sewage disposal described below in order to avoid lawsuits instituted to prevent alleged stream pollution by sewage.

The population of the city increased from 4,226 in 1880 to 11,140 in 1890. Water-works were built in 1879 and a sewerage system in 1888. Sewage was first used for irrigation in 1889. Jan. 1, 1893, there were in use 20.4 miles of separate sewers, 239 manholes, all with perforated covers, 683 house connections and 18 flush tanks.

A statement of the causes which led to the use of sewage for irrigation, and a description of the sewage farm have been sent to us by Mr. H. I. Reid, City Engineer and engineer of the disposal plant, as follows:

In the utilization of sewage for irrigation purposes at Colorado Springs, no attempt is made toward treatment or purification other than by natural means and in a rather primitive manner. The system was adopted as a compromise measure to avoid suits for damages for the alleged pollution of the stream into which the outfall sewer originally emptied, "Fountain Qui Bouille," commonly known as Fountain Creek. This stream has a normal flow at the sewer outlet of 50 cu. ft. per second, but at times during the irrigating season this is reduced to almost nothing, although during the same season floods may be expected, when for a few hours or days the creek becomes a swift flowing river, with a fall 30 to 40 ft. per mile.

The original sewerage system was put in operation in 1888. The following year a ranchman, living some two miles below the outlet point, shown in Fig. 68, instituted injunction proceedings to prevent the sewage from being turned into the stream, claiming that his well, situated near the stream, was so polluted as to render it unfit for drinking purposes, and that the water in his irrigating ditch, the head gate of which is ¾ miles below the sewer outlet, was so foul that stock would not drink it. Before the suit came to trial the city council appointed a committee, of which the writer was one, to try and arbitrate the matter. This was done and the suit was withdrawn, the city paying all costs of proceedings to that date, and agreeing to divert the sewage at some point on the outfall and utilize it for irrigation on the lands designated on the accompanying map, Fig. 68.

A contract was made between the city and the owner of this land, whereby the city was to deliver the sewage at the point B, Fig. 68, by the line A B, and to pay annually $300 for five years, said owner to receive the sewage at this point and use the same for irrigation purposes in such a manner as he deemed best, provided, however, that he prevent the sewage from flowing directly into the creek, and provided, further, that if the method of irrigation was not satisfactory to the ranchman bringing the suit, or to the city, then the city should have possession of the land and use such methods as it thought best. At the expiration of the contract the city has the option of buying the land at a stipulated sum, and probably will buy it, although there are now many parties who would pay for the sewage delivered to their land.

The city tapped the outfall at the point A, Fig. 68, and by means of an underground wooden conduit on a less gradient than the original outlet delivered sewage on the surface of the ground at the point B, whence the lessee takes charge of it and delivers it to grounds by the ditches B E, and B C D, and thence by laterals to any desired point.

The map shows that many years ago the stream followed a different channel than the present one,

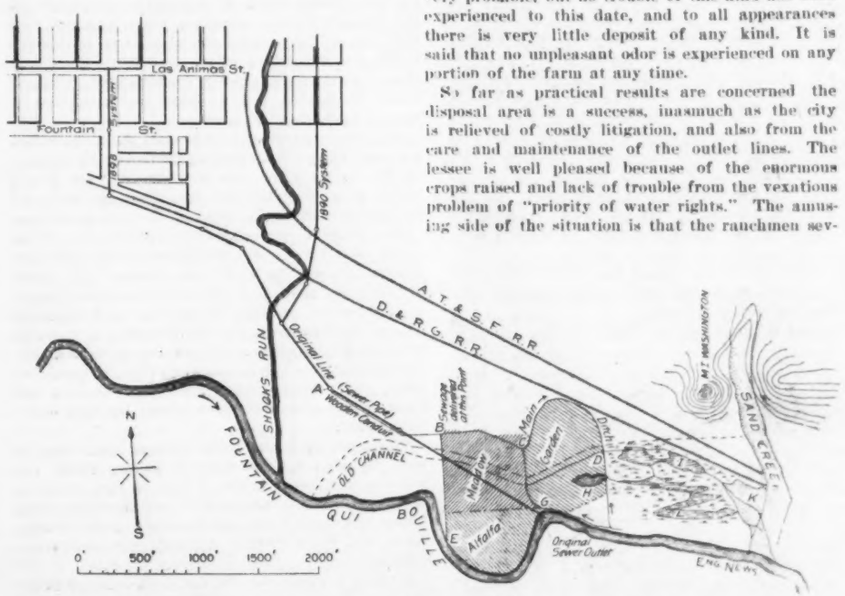


FIG. 68. PLAN OF SEWAGE FARM AT COLORADO SPRINGS, COLO.; H. I. Reid, C. E., City Engineer.

the depression of which extends through the entire tract from west to east, and is from 3 to 4 ft. lower than the north bank of the creek at corresponding points at right angles thereto. The old channel is the medium whereby the surplus sewage is carried off without flowing directly into the creek.

The sewage is distributed by means of small ditches or furrows through the garden tract, whence all liquid matter not absorbed by the earth flows back into this old channel, and thence into the depressions, forming small reservoirs at H. I. I., Fig. 68. The small laterals radiating from the main ditch irrigate the northern portion of the lands, and in a similar manner any surplus flows into the same reservoirs. During the irrigation season, which, in this instance, is from March 1 to Nov. 1, there is but little surplus, the character of the soil being such that the greater portion is absorbed or carried off by underflow.

In constructing the outlet sewer, we found throughout this entire tract of valley land from the surface to a depth of 2 or 3 ft. loose black loam, then a 2-ft. stratum of sand, below which was coarse gravel and sand, through which water was flowing with considerable velocity, so that at a depth of 6 ft. it was found necessary to dig a parallel and deeper trench to carry off the water, in order to facilitate pipe-laying. This probably explains the rapidity with which the sewage matter is absorbed when applied for irrigation. As soon as sufficiently dry, after each application of sewage, the soil is thoroughly pulverized and any accumulation of solid matter turned under before receiving more sewage.

When irrigation is not in progress the entire flow is carried through the main ditch and emptied into the old channel and depressions mentioned. The upper pools or reservoirs, Fig. 68, were ploughed out by the action of surface water; the lower or most easterly one is a reservoir, the dam of which was built up through a similar agency. Immediately north of the railway tracks are sand and gravel hills, some 200 ft. higher than the valley and very steep. During the rainy season flood water flows into Fountain Creek, across the valley at right angles to the old channel. At such times the debris brought down has been deposited upon the lower level of the valley and a sand dike several hundred feet wide and 5 or 6 ft. higher than the lowest portion of the valley has been formed, thus converting the valley at this point into the basin, K, Fig. 68, the area of which is some three or four acres. All surplus sewage matter collects in this basin and rapidly seeps away into the underflow and finally into the creek. All solid matter is deposited in the basin, and that it will in time cement the bottom and fill it up is very probable, but no trouble of this kind has been experienced to this date, and to all appearances there is very little deposit of any kind. It is said that no unpleasant odor is experienced on any portion of the farm at any time.

So far as practical results are concerned the disposal area is a success, inasmuch as the city is relieved of costly litigation, and also from the care and maintenance of the outlet lines. The lessee is well pleased because of the enormous crops raised and lack of trouble from the vexatious problem of "priority of water rights." The amusing side of the situation is that the ranchmen several miles below the outlet, seeing the sewer farm well supplied with water at times when they had none, threatened to enjoin the city from using it for this purpose, and compel the sewage to be turned into the stream for their benefit.

The sewer farm comprises at present an area of about 35 acres, but may be added to as future needs require. In 1892 the sewage was used on 25 acres, 15 in meadow and alfalfa and 10 acres in vegetables, but a larger acreage could be used with the present amount of sewage. The crops produced are enormous, and owing to close proximity to the market the farm is a paying investment. As already stated, the city has nothing to do with the management of the farm, but the probabilities are that when the lease expires the city will buy the farm and enlarge the system.

Under date of Jan. 24, 1893, Mr. Reid wrote that he had recently visited the sewage farm, and found the sewage running directly into the creek through a ditch cut from the reservoirs, shown in the plan, Fig. 68. This is in direct conflict with the terms of the agreement, but it may be that it was done to flood the lands of ranchmen below, who have recently been willing to take all the sewage they can get.

Trinidad, Colo.

The city of Trinidad is divided into two parts by the Las Animas River, a comparatively small stream during much of the year. The farmers be-

low the city depend upon ditches leading from the river for water for domestic use, which makes especially necessary some form of sewage purification. Following the advice of Mr. Norval W. Wall, City Engineer, it was decided to purify the sewage by irrigation. A contract was therefore made with Mr. Jas. M. John, who was mayor at the time, to receive and dispose of the sewage on land owned by him, the city paying Mr. John $500 per year and delivering the sewage to him.

The population of Trinidad in 1890 was 5,523, and in 1880 it was 2,226. A public water supply was introduced in 1879 by the Trinidad Water-Works Co. A sewerage system was put in operation in 1892, the outfall sewer having been completed about three months before the close of the year. Mr. Wall was engineer for the system.

On Jan. 1, 1893, there were in use two miles of separate sewers, 18 ventilated manholes, two Rhodes-William flush tanks and 12 house connections, mostly public buildings.

An 18-in. vitrified outlet sewer 7,100 ft. long leads from the city to the sewer farm. This outlet has a calculated velocity, when running full, of 2.58 ft. per sec.

At the farm end of the outlet sewer there is a masonry settling tank 50 ft. long, 5 ft. wide and 4 ft. deep. Mr. Wall states that in time of an epidemic the tank can be used to disinfect as well as to precipitate the sewage; also that more tanks are proposed when the sewerage system is extended.

The sewage farm slopes toward the Las Animas River at the rate of from 2½ to 3½ ft. per 100, and is laid out with embankments following natural contours, as shown in Fig. 69, except that a total of 15 embankments have now been made. The embankments are from 25 to 50 ft. apart and average about 1,500 ft. in length. Wooden sluice boxes provide means for the passage of sewage through the embankments to lower areas. To the close of 1892 about $1,200 had been expended by Mr. John in preparing the farm to receive sewage.

It is stated that blue grass is proposed as a crop on the farm, as it will stand more frequent irrigation than any other crop.

We are indebted to Mr. Wall and Mr. John for

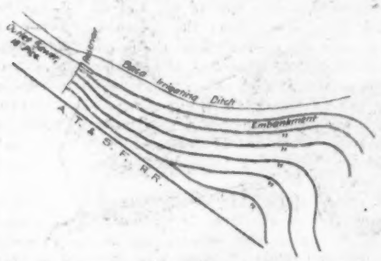


Fig. 69. Sketch Plan of Sewage Farm, Trinidad, Colo.; Norval W. Wall, C. E., City Engineer.

the information presented, a part of which, only, Mr. Wall gave in a paper read before the annual meeting of the American Society of Irrigation Engineers in Denver near the close of 1892.

Fresno, Cal.

A very interesting example of the use of sewage for irrigation is found at Fresno, Cal., where the city pays $5,000 per year for the disposal of the sewage, and the fortunate man who receives the money distributes the sewage over land which he rents to Chinamen for market gardens.

The population of Fresno has increased from 1,112 in 1880, to 10,818 in 1890. A public water supply was introduced in 1876 by the Fresno Water Co. The city put a sewerage system in operation in January, 1890. Shepard & Teilman, of Fresno, were engineers for the system, Mr. J. C. Shepard, of the firm, having been city engineer at the time. Sept. 5, 1892, there were included in this system about eight miles of sewers on the separate plan, not including the outlet sewer, which consists of about 4½ miles of 24-in. vitrified pipe laid to a grade of 3½ ft. per mile. The last three miles of the outlet sewer is ventilated once in every 1,000 ft. by a 24-in. vertical pipe extending above the ground. Jan. 1, 1893, there were in use about 600 house connections and six flush tanks. In addition to the flush tanks there is at four points a continuous flow of water into the sewers about equal to a 2-in stream under a 6-ft. head. The lower end of the outlet connects directly with an irrigating ditch.

We are indebted to Shepard & Teilman for the information here given regarding the sewage farm, the remainder of which is presented practically as reported by them on Sept. 5 and Oct. 21, 1892, as follows:

Prior to the construction of the sewers the city trustees thought the disposal of the sewage the great obstacle to be overcome; therefore they called for proposals to take care of the sewage for five years, the successful bidder to give a bond of $10,000 to protect the city from all damages which might arise therefrom after its delivery at the end of the pipe. Alexander McBean, of Oakland, was the lowest bidder, and his bid of $5,000 per annum was accordingly accepted. The contractor purchased 80 acres of land at the end of the outlet sewer, and for one year the sewage ran upon that land without any attention or care, except when occasionally some neighbor saw fit to take it for irrigation. The second year the contractor constructed ditches and leased the land to Chinamen for vegetable gardens, and for two seasons it has been used for irrigating gardens and vineyards.

Mr. H. Burley, of Fresno, superintends the renting of the land, which is all under cultivation with all the various kinds of vegetables commonly in the market, such as potatoes, yams, parsnips, lettuce, celery, beans, peas and corn. It is customary to irrigate vegetables in furrows only. Trees and vines would be irrigated in furrows also. Grasses would be flooded, but we have no knowledge of sewage being used on grasses.

As to the amount of sewage used on the 80 acres, we cannot say. The 24-in outlet sewer on a grade of 3½ ft. per mile runs continuously, we should judge, about one-third full, but what proportion of the flow is used on the sewer farm we do not know.

Mr. Burley, the superintendent of the farm, states that he can see no difference between irrigating with sewage and clear water. It is possible that the land may produce good crops longer by the use of sewage, but that is to be proved. The general impression is that sewage is superior to water for irrigation. The sewage farm is an exceptionally poor piece of land, but it produces pretty well with sewage irrigation. We do not know what a similar piece would do with clear water only.

When put upon the land, without more dilution than is given by the flushing water, unless the land is cultivated within a day or two, there is quite a stench, but when cultivated this disappears. There has been no complaint regarding the sewage farm, and the $5,000 is a yearly pension to the contractor.

When not needed on the farm, the sewage is allowed to float in the irrigating ditches for miles beyond, in which way it becomes very much diluted, and in the irrigating season is used throughout the country below the sewage farm proper.

Pasadena, Cal.

After an unfortunate experience with the Pacific Sewage Co., an organization which agreed with the city to construct a disposal system similar to that in use at Atlantic City, N. J. (Eng. News, Feb. 9, 1893), but failed to do so, and after two years of litigation over right of way for the outlet sewer, the city of Pasadena in the middle or the latter part of 1892 began the preparation of a farm for the disposal of the sewage of the city. It is expected that this farm will be put in use in the season of 1893, as decribed below.

The city is of comparatively recent origin, its population in 1880 having been but 391. The present population is estimated at 6,000, the last census showing 4,882 inhabitants. Water was supplied here, probably in connection with irrigation works, as early as 1869, and at present several companies operate works. The construction of a sewerage system was begun in 1887, but for the reasons stated above there has been much delay in providing for the disposal of the sewage, which has prevented the making of house connections, although in 1891 nearly five miles of sewers had been built within the city limits. Mr. August Mayer, of Pasadena, is the engineer for the whole system, which is of the separate type. We are indebted to Mr. Mayor for the following information relating to the sewage farm, the matter having been prepared in November, 1892:

The city of Pasadena lies in the midst of the San Gabriel Valley, at the foot of the Sierra Madre Mountains, 10 miles northerly from the city of Los Angeles, and about 30 miles from the Pacific Ocean. Its elevation above the latter may be taken at 900 ft., or about 600 ft. above the main part of Los Angeles. The soil around the city, and especially that close to the mountains, is sandy, with excellent underdrainage. The general slope toward the ocean in the vicinity of the city is 2 ft. per 100 ft. The grades obtainable for sewerage in the city, with one or two exceptions, are excellent. The average annual rainfall amounts to 20 ins., which is precipitated chiefly during the months of January, February, March and April. The average temperature during the rainless eight summer months may be taken at 85° F. The air is dry.

Wherever water is obtainable for irrigation, citrus fruit is principally raised, while the unwatered land is fit only for the raising of some deciduous fruits, grapes and barley; the latter being chiefly cut, in this vicinity, before its maturity and used for hay. Bare land is worth $100 per acre without water, while watered land is held at about $600 per acre. Irrigation, therefore, makes the land valuable, and since water is here only obtainable from springs or storage reservoirs, of which latter we possess at this place none at the present, waste of water is hardly ever met with. It may seem, therefore, that the circumstances for successful sewage disposal, by means of irrigation, from a financial as well as sanitary standpoint, are in our favor.

The sewage farm is owned by the city, and comprises 300 acres of land situated about four miles from the city in a southeasterly direction, in a well settled part of the valley. The soil is a sandy loam, mixed with some alkali. It has the capacity of absorbing a considerable quantity of water. It is estimated that for the present only 40 acres will be required for the disposal of the sewage, but the latter may be spread over a much larger area for the purpose of irrigating crops on the remainder

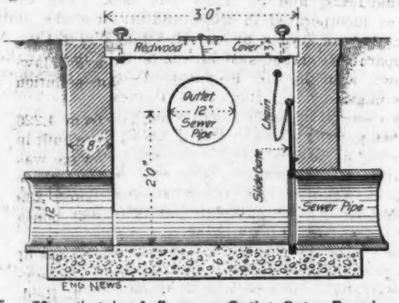


Fig. 70. Sketch of Sewage Outlet Gate, Pasadena, Cal.; August Mayer, C. E.

of the farm. Most of the land will probably continue to be devoted to the raising of barley hay, until fruit orchards are planted. The land originally cost $125 per acre, or a total of about $40,000, including some extra expenses. The gross yield in barley hay, without irrigation, is $4,000 per annum, or 10% on the cost; the net yield amounts to about $3,000, 7½% on the money invested.

It is the intention to devote the land irrigated with sewage to the raising of vegetables, berries, and citrus fruits, and perhaps walnuts and alfalfa hay. The latter yields about seven crops per annum, or about 10 tons per acre, and is sold for $10 to $15 per ton. It stands any amount of irrigation at all seasons, and the sewage may be crowded on it at any time. Vegetables are calculated to yield $25 net per acre, while berries, as a rule, yield from $100 to $200 per acre per annum. Citrus fruits often net from $150 to $400 per acre per annum. With sewage irrigation, these figures may possibly be exceeded.

As seen from the section of the outlet gate, Fig. 70, the sewage is taken from the sewer in much the same manner as water from irrigating pipes by the simple closing of a cast iron slide gate, built into a manhole, through which the pipe leads. The sewage is thus backed up into the sewer until it rises nearly to the top of the manhole, whence it

finds its way through a joint of sewer pipe into the main carrier, an earthen ditch 20 ins. wide at the top, 10 at the bottom and 10 ins. deep. This carrier has a grade from 4 to 6 ins. in 100 ft. The land which the main carriers cover is divided into fields 100 ft. in width, and from 200 to 400 ft. in length. The slope of the fields at right angles to the main carriers is 1½ to 2½ ft. per 100 ft. To irrigate the fields a dam of earth or of redwood board is inserted in the carrier at the lower end of the field, and the sewage is thus diverted into numerous small furrows from 3 to 6 ins. deep and 1 ft. apart, previously made with a common cultivator. Each field is expected to take the sewage for at least 12 hours. After the first soaking the dam is removed and the next field in order will receive its charge, and so on. As soon as the ground permits it, say, in about two days, field No. 1 will be thoroughly cultivated, to keep the ground from baking hard and to allow the air to act upon the soil. This is the common course adopted here for irrigation with pure water.

Fruit trees are planted in regular lines about 20 ft. apart each way, which permits the manner of irrigation here described. The side and bottom walls of the main carriers will be raked over with a garden rake whenever it becomes necessary to prevent the ditch from becoming foul.

Berries are to be planted in rows about 8 ft. apart, and the sewage will be led in between the rows so that the ground can be well cultivated. Vegetables may be planted in single or double rows, as the case may require, and the sewage will be conducted in between the rows or fields in flat trenches, which are to remain filled until the ground from trench to trench is thoroughly saturated with the sewage water, when the trenches will be drained, and after having dried off sufficiently they will be cultivated.

Redding, Cal.

Redding is one of the smallest towns in the United States using sewage for irrigation, or having a sewerage system; its population in 1890 was 1,821, and in 1880 but 600. The town was incorporated in 1888, and water-works built in the same year by the Redding Water Co. A separate sewerage system was built in 1889 by the town, with the City Engineer, Mr. S. E. Brackins, as engineer, and Bassett & Touhey, Sacramento, as contractors, who also agreed to dispose of the sewage for 40 years. Jan. 1, 1893, there were 2.9 miles of sewers, and seven Field-Waring, 112-gallon flush tanks.

The following description of the sewage farm and matters pertaining to the disposal of sewage was prepared for this series of articles in the latter part of October, 1892, by Mr. L. F. Bassett, C. E., the present owner of the farm, and for eleven years city engineer of Sacramento:

Redding is situated on slightly rolling ground, at an elevation of 550 ft. above the sea. It is bordered on the northeast and southeast by the Sacramento River. The climate ranges from 16° above zero in the winter to 107° F. above in summer. Most of the season the atmosphere is dry and evaporation rapid.

It was the original intention of the town to discharge its sewage into the Sacramento River, but objection was made at Sacramento, where water is taken from the river to supply the city, and the State Board of Health gave notice to the authorities of Redding not to discharge the sewage into the river. The town authorities thereupon requested bids for taking care of the sewage, and a contract was entered into for a term of 40 years, the sewage to be disposed of at $300 for the first year, the amount of yearly payment thereafter to increase in proportion to the increase of the assessment roll.

The contractors immediately purchased a tract of about 100 acres of land within the corporate limit, shown by Fig. 71, and prepared a portion of it, about a mile from the built-up part of the town, for the utilization of the sewage by irrigation. The land selected is comparatively level and the soil a sandy and gravely loam 4 to 6 ft. in depth, underlaid with gravel. Land better adapted to the purpose would be hard to find. About 10 acres have been prepared for irrigation by leveling and constructing open carrier ditches, elevated above the surface of the land to be irrigated.

The sewage is applied directly to the land by the broad surface irrigation system, either by being run in furrows between rows, or spread over the surface, according to the requirements of the crop. The sewage has been applied to various crops, grain, asparagus, potatoes, turnips, beets, orchard and some garden truck. It has been principally used in raising fruit trees for nursery stock, the young trees being irrigated between the rows. About five acres are used as a nursery.

Generally the land is cultivated as soon after an application of sewage as the soil becomes dry enough. Part of the year it is necessary to put the sewage on land on which no crops are growing. It is then customary to run the sewage on the same piece of land for several days in succession, and after it becomes sufficiently dry to plow or cultivate it. This is more particularly the case in winter, when there is sufficient moisture for crops without irrigation.

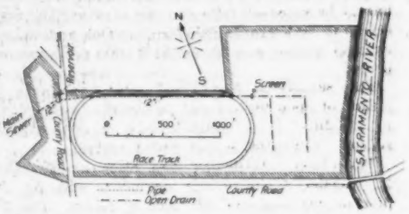


Fig. 71. Plan of Sewage Farm, Redding, Cal.; S. E. Brackins, Engineer; Bassett & Touhey, Contractors

The sewage is not allowed to flow continuously onto the land, as too much time would be required in taking care of it, besides which the ordinary flow is not of sufficient volume to operate successfully. As shown by the plan, Fig. 71, a reservoir was constructed at the outlet of the sewer, at the upper line of the sewage farm. This reservoir has a capacity of 75,000 gallons, which is about equal to the daily sewage flow in the dry season. Each morning the outlet to the reservoir is opened, and the contents discharged in from two to four hours, as desired. The bottom and sides of the reservoir are so constructed that everything gravitates to the outlet, and special cleaning is seldom necessary. An abundant supply of water from the town water-works is at hand for use, if required. The reservoir is covered with a rough board structure and a vent chimney of lumber is carried to an elevation of about 60 ft. This has been sufficient to prevent any nuisance, and none is complained of, although the reservoir is alongside the public road.

No difficulty has been experienced in preventing a nuisance on the irrigated lands. Care and attention to secure proper distribution and cultivation are required, and with these the results have been satisfactory. There is sometimes a slight odor in the immediate vicinity of freshly-irrigated land, or where it is ponded previous to its subsidence into the soil, but this odor is not noticeable at a distance of 200 ft.

A screen near the upper line of the irrigated lands (see Fig. 71) catches such large objects as might cause an obstruction in the ditches, or interfere with the free flow of the sewage over the soil. There has been no underdrainage, as none is required, the soil being very porous and underlaid with an extensive bed of gravel.

There has been some prejudice against the sewage farm, but this is gradually dying out. The principal objection came from two owners of land immediately south of the tract under irrigation, who, from the first, objected very strongly to the location of the sewage farm so near them. One of these men in June, 1892, had the proprietor of the farm arrested for maintaining a public nuisance. At an examination, held shortly afterwards, the examining magistrate decided that the evidence was not such as would secure a conviction, and the case was dismissed.

The sewage farm is now the property of L. F. Bassett, C. E., of Sacramento, who gives personal attention to the manner in which the sewage is disposed of. Besides the sewage, fresh water from the Sacramento River, sufficient for 40 acres, is available for irrigation.

Los Angeles, Cal.

The use of sewage for irrigation at Los Angeles has been temporarily abandoned, with the exception of quite a small part of the daily flow, but preparations are being made for the future utilization of all of the sewage of the city during the irrigation season. The reasons for the change from the old to the proposed new plan of sewage disposal are given below.

Los Angeles grew from a population of 11,183 in 1880 to 50,395 in 1890, making it the second city in size in the state. Water is supplied by several different companies, some or all of which recently consolidated. The works of the Los Angeles City Water Co. were built in 1862. The date that sewers were first put in operation is not stated in the information at hand. Dec. 31, 1891, about 46 miles of separate sewers had been built.

The following account of the use of sewage for irrigation, the cause for its discontinuation, and an outline of the new disposal system was prepared by Mr. J. H. Dockweiler, City Engineer, on Oct. 21, 1892, and we are also indebted to Mr. W. W. Robinson, clerk of the mayor, for information furnished:

Up to about three years ago, the entire sewage of our city, amounting to 7,000,000 gallons in 24 hours, was disposed of by irrigation on 1,700 acres of sandy soil adjoining the southern limits of the city.

The sewage was delivered to the South Side Irrigation Co., at the southern limits of the city, who distributed it to the different land owners through open ditches owned and controlled by the company. Previous to the time that this company handled the sewage and properly disposed of the same, the yearly rental value of the land was about $2.50 per acre, but as soon as sewage was used for irrigation, these same lands rented for from $15 to $25 per acre per annum. Save a few acres of land which were irrigated by the surplus waters from the irrigation ditches in the city of Los Angeles, this land, known as the Vernon District, could not be irrigated because of lack of water. The only water that could be depended upon by the Vernon District came from the city sewers.

During the "boom" of a few years ago a great deal of the land of the Vernon District was cut up into lots and sold. A great many residences and improvements sprung up, and the sewage became a nuisance from the following causes: It was carried in open ditches; the people had to take it whether they wanted it or not; the hitherto irrigable area was reduced by subdivisions into house lots, while the quantity of sewage was continually increasing; the owners of lands suitable for irrigation were more interested in selling their land for residences than developing it for cultivation.

At this stage injunction suits were brought against the South Side Irrigation Co. to compel them to carry the sewage in closed conduits through the lands of those who objected to open ditches, and also to restrain them from delivering sewage to lands when it was not required by them. The city had only one point of delivery, and could not control the volume of the sewage; whatever the sewer discharged at the south city line, the South Side Irrigation Co. had to dispose of. The injunctions were granted, so the company turned the sewage into the river, where it now goes to waste, save that a few acres are still irrigated by it.

The present feeling in this district, however, is that sewage would be used, if it were delivered in closed conduits, only when required.

The city has voted $395,000 worth of bonds to construct an outfall sewer 12 miles long from the southwest corner of the city to the Pacific Ocean. The line passes through a large section of country which cannot be irrigated at present for want of water. The sewer has been so located that it will deliver sewage upon the lands at the highest possible level; in fact, it was located as nearly as an irrigation ditch as is consistent with reaching the ocean in as short a line as possible. It is expected that the outfall will be completed by July, 1893. Provision has been made to supply sewage to land adjacent to the outfall by means of gates and hydrants located at the commanding points. There are at least 20,000 acres of sandy soil suitable for sewage irrigation directly under the location of this sewer, the owners of one-half of which have signified their willingness to irrigate with sewage. The city will deliver the sewage along the line of the outfall, the land owners to

make the necessary provisions for getting it on the land. The special feature which will make irrigation with sewage a success by this plan is that when not required on the lands it will be turned into the ocean, thus making it possible to use it for nine months in the year. It is proposed to charge about $3 per acre per annum for the use of the sewage.

I have designed two inverted siphons, each three miles long, in connection with the outfall, to be made of wood stave pipes.

Mr. Dockweiler states that he believes that the above will be the first instance of the use of wood stave pipe in a sewerage system. In our issue of Jan. 19, 1893, there was described and illustrated a 24-in. wood stave outlet sewer extending for 800 ft. beneath the Harbor at New London, Conn.

In the report of the State Board of Health of California for the two years ending June 30, 1890, there appeared a paper by Mr. D. G. McGowan, Health Officer of Los Angeles, from which the following extract is taken:

> At the southeast angle of the city limits this water (sewage) is taken by the South Side Irrigation Co. and conducted through a 22-in. cement pipe a distance of six miles to the sandy plains below the town of Florence. Though eagerly taken at first by the Chinese market gardeners for irrigating and enriching their truck patches, its prolonged use has been found to be a detriment, lessening the productive qualities of the land when it becomes well saturated with the sewage matters. It is a fact that lands upon which it has been used constantly for several years have been abandoned by their cultivators, or it has been necessary to pipe pure water upon them to take the place of sewage for the purpose of irrigation.

The above statements, when taken in connection with the prior explanation of the abandonment of the use of sewage from the ditches of the South Side Irrigation Co., lose much of the force which they seem to have by themselves. It is doubtless true that the land was overdosed with sewage, and it is quite probable that little or no proper attempt at a rotation of crops was made.

Santa Rosa, Cal.

The population of Santa Rosa in 1880 was 3,616, and in 1890 it was 5,220. The Santa Rosa Water Co. built water-works in 1873. A few streets were sewered on the separate plan some years ago, sewage being discharged into Santa Rosa Creek, near the city limits. Complaints of pollution of the creek, followed by a lawsuit, led to the purchase by the city of between 18 and 19 acres of land about two miles from the city, to which an outlet sewer was built.

The farm is leased to parties who take care of the sewage for rental, using it for gardening purposes. The city can terminate the lease at any time. The year the farm was put in operation is not stated, but it was used as early as 1890, and probably at least one or two years earlier.

A slight rise near the end of the outlet sewer causes the coarser solid matter to collect. Once a day, or as often as is necessary, a gate is opened and the collected matter flushed out into a pit near the bank of the creek.

When not used for irrigation the sewage flows onto low land near the bank of the creek, which land is flushed at high water. Mr. Newton V. V. Smyth is city engineer, and to him and Mr. J. L. Jordan, City Clerk, we are indebted for the information given.

Helena, Mont.

About one-fourth of the sewage of Helena is used for broad irrigation on a farm owned by the city and leased to Mr. A. T. Newbury for five years from 1890, prior to which it had been leased for about two years to another man.

Helena had a population of 3,624 in 1880 and 13,834 in 1890. Water-works were built in 1887-8 by the Helena Water Co., and a sewerage system was put in operation in 1889. Oct. 7, 1890, there were 25.8 miles of 6 to 24-in. sewers, receiving no rain water except from roofs. There were on the same date 616 house connections, 307 manholes with perforated covers and 78 Field flush tanks every 16 hours discharging 200 gallons. Mr. G. N. Miller was engineer of the sewerage system.

From the last house connection in the city the outlet sewer extends about one mile, with branches not in use up to Sept. 11, 1892. Next comes 1,200 ft. of 12-in. vitrified pipe, then 700 ft. of wooden box sewer 12 ins. square. The end of the box sewer connects directly with the distributing ditches of the farm. The sewage, when not used for irrigation, runs across the farm into and through two ditches extending for about 2½ miles to Ten Mile Creek, a stream about 20 ft. wide and 1 ft. deep.

The city paid $6,100 in 7% bonds for the 40 acres of land, included in the farm, which has received sewage for about four years. The lessee pays the city a rental of $200 in cash, plants 100 trees and makes one acre of lawn per year, caring for the trees and lawn. It is said that the lessee raises vegetables and all kinds of nursery stock on the farm. In connection with the statement, made below, that the farm has never paid the interest on the cost it must be remembered that this could hardly be expected from the use to which the farm seems to be devoted; nor, for the same reason, can efficient purification throughout the year be expected.

The sewage is distributed over the farm by means of open ditches and is brought to the plants by flooding. It is utilized only in the growing season. The land is not underdrained.

The above information was given by Mr. Geo. K. Reeder, formerly city engineer, and by the present city engineer, Mr. Jas. S. Keerl. The following additional facts and opinions regarding the operation and success of the farm are given substantially as reported by Mr. Reeder, in letters dated July 31 and Sept. 11, 1892:

The sewage is only utilized in the growing season. During the winter months, or rather when the ground is so frozen that there is no absorption, the sewage is allowed to flow in the natural channels upon the surface. During some portions of the year, even when not used for irrigation, the sewage scarcely gets across the field before being absorbed or evaporated.

The farm has never proved a source of income to the city, in fact, it has never paid the interest on its cost, and has not proved a success in disposing of sewage throughout the whole year. My own opinion is that the soil is not suitable for the purpose, it being a quite gravely, sandy loam for a depth of 6 ins., beneath which is a bed of quite impervious clay and gravel. The land may become more suitable after years of working. The city authorities, in their lease, have virtually turned over all control of the sewage to the lessee, and so far the tenants have done as they pleased.

As nearly as I could ever learn from the aldermen, the intention in establishing the farm was ultimately to convert it, or at least a portion of it, into a park, sewage to be supplied to the trees by means of porous tiles. My predecessor, as city engineer, intended to make it an absorption farm, sewage to be turned onto one portion until it would absorb no more, then to another, and so on, each portion after drying out to be turned over by cultivation to fit it for a new dose of sewage. This was to be done irrespective of seasons, and crops were to be a secondary consideration. City engineers propose but city councils dispose, and there never has been a time when the city engineer has had control over the farm, the lease having always been of such a character that his hands have been tied.

Cheyenne, Wyo.

Regarding the former use of the sewage of Cheyenne for irrigation, the following information has been given to us by Mr. Fred Bond, City Engineer, under date of Aug. 28, 1892:

The sewage, direct from the sewer outlet, was discharged directly into the irrigating ditch of a private ditch owner, and mixed therein with water already in the ditch, which was taken from the creek a little further up, or above the point where the connection with the sewer was made. In this way the creek water and sewage were mixed and carried to the land to be irrigated. The man who used the sewage did not pay for it, the obligations between the city and himself being considered mutual. He used the sewage seven or eight years, I believe. The sewage is now discharged into the creek about 2,500 ft. below the point where it formerly entered the private ditch.

Cheyenne had a population of 3,456 in 1880 and of 11,690 in 1890. The city built water-works in 1882 and sewers were put in use in 1883 on the separate plan. On Feb. 20, 1891, about five miles of 9 to 15 in. vitrified, salt-glazed sewer pipe had been laid.

The use of sewage for irrigation was stopped on account of the extension of the outlet sewer to discharge below the ditch of the man who made use of the sewage.

Stockton, Cal.

Provision for the use of sewage for irrigation has been made at Stockton, Cal., but the fact came to our attention too late to secure exact information. The construction of a sewerage system was begun in 1891, under the direction of Mr. George Atherton, City Surveyor. All the sewage is pumped into an outfall sewer 14 ins. in diameter and two miles long, discharging into the Stockton River. It is stated in the San Francisco "Chronicle" of Jan. 31 that at regular intervals on the outlet sewer gates are placed "by means of which the property owners turn the sewage upon the land during the dry season for irrigation purposes."

The population of Stockton in 1890 was 14,424.

THE COMPETITIVE TESTS OF THE WESTINGHOUSE AND NEW YORK AIR BRAKES ON THE NEW YORK CENTRAL R. R.

On Sept. 8, 9 and 10, 1892, tests of the brakes on two 50-car trains, one equipped with the Westinghouse air brake, the other with the New York brake, were made on the New York Central R. R., at Karners (near Albany), under the direction of Mr. P. H. Dudley, M. Inst. M. E., acting as expert for the railroad company. These tests were made with great care and with better facilities for the elimination of inaccuracies and the securing of an absolutely reliable record than have ever been available in any brake test which we now recall.

To understand the importance of the records obtained it is necessary to review the occurrences which preceded them. At the close of 1891 the New York Air Brake Co. had been successful in placing large contracts for the sale of its quick-action automatic air brake for use on freight cars, which was claimed to be interchangeable and equally efficient with the Westinghouse, and was, in fact, identical with it save in the construction of the most important feature of the whole air brake mechanism, the triple-valve. On Dec. 24, 1891, tests of the New York triple valves were made in the testing rack of the Westinghouse Air Brake Co., and developed the fact that the quick-action feature of the valve was unreliable. This was confirmed by train tests made on the Chicago, Burlington & Quincy at Aurora shortly after, and seems to have been independently discovered by the New York Air Brake Co., as it was at once announced that a new triple-valve had been perfected in which the quick action was as reliable as in the Westinghouse. This new valve was tested in competition with the Westinghouse on 50-car trains at Burlington, Ia., on Feb. 3, 4 and 5, 1892, (Eng. News, Feb. 13) and a new difficulty developed with the New York brake—it would not release after an emergency stop. Further tests were made on the Lehigh Valley R. R. (Eng. News, Feb. 27, 1892), which showed the same difficulty with the New York brake, although it was claimed that in a subsequent test this difficulty was overcome.

The New York Central tests were made six months later, when the New York Brake Co. had had ample time to test and perfect its new valve and remedy any defect of workmanship or design. It was fair to suppose that the results then secured would be a good showing of the best the company could do.

The tests made at Karners were witnessed by many railway officials, and by representatives of several of the technical journals. It was mutually agreed, however, that no statement of the results of the tests should be published until Mr. Dudley had time to compile and present his official report, when the full statement of the results could be given in connected form. Five months have now elapsed since the tests were made. Mr. Dudley's report has, we understand, been completed and presented to Mr. H. Walter Webb, head of the New York Central operating department. Our application to Mr. Webb for a copy of this report has been ignored, and we understand that a like fate has met similar requests from other technical journals and from one of the brake companies which, at the request of the New York Central Co., spent considerable time and money in equipping a 50-car train for the test. To the other competitor Mr. Webb gave for publication

within a month of the completion of the tests a letter (Eng. News, Oct. 13) announcing that the results of the test showed that "from a practical operating standpoint there was no difference between the operation of the two brakes."

Under these circumstances we believe many railway officials will be desirous of examining the records of the tests, and forming their own conclusions concerning them. As the official report is withheld from publication it seems only fair that such data of the tests as were taken by those who witnessed them should now be made public through the railway journals. The compilation of this matter has been made by the "Railroad Gazette," and is given as follows, including so much of the records and observations of Mr. Dudley as are known.

The official programme included both standing and running tests, and was carried out with no material variation. The trains tested were a 50-car train with Westinghouse equipment throughout and a train of the same length with New York equipment on all the cars and Westinghouse pump and engineer's valve. The train-pipe pressure was

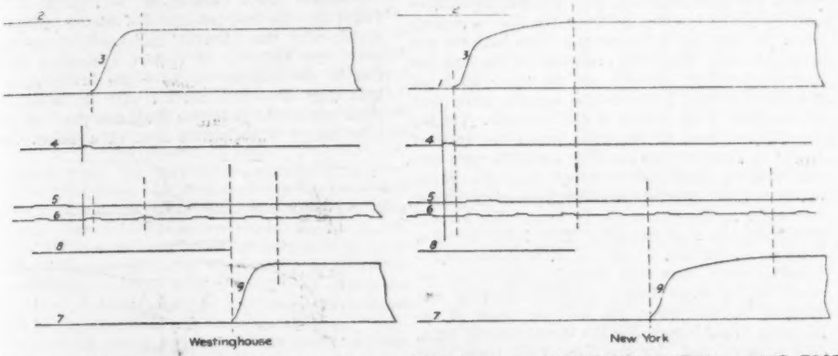


FIG. 1. SPECIMEN AUTOMATIC RECORD OF DYNOGRAPH IN NEW YORK CENTRAL BRAKE TEST.

Explanation:
Line 1. Zero pressure in brake cylinder, first car.
" 2. Train-pipe pressure at first car.
" 3. Application of brake, first car.
" 4. Opening of engineer's valve.
" 5. Ten-second interval chronograph record.
Line 6. One-second interval chronograph record.
" 7. Zero pressure brake cyl., 50th car.
" 8. Train-pipe pressure at 50th car.
" 9. Application of brake, 50th car.
Vertical scale, 144 lbs. = 1 in; horizontal scale, 3.15 sec. = 1 in.

maintained at 70 lbs., as closely as possible, and the brake piston travel was adjusted at 5 to 7 ins. The locomotives were duplicates of each other, and were built on one order by the Schenectady Locomotive Works. All the cars of both trains were turned out in one order by the Buffalo Car Mfg. Co., and had been in service for about three months, so that the results obtained represented not the condition of new, clean and well-oiled brakes, but the average condition of brakes in service. Neither brake company was allowed to repair or interfere with the condition of the brakes on the cars, and the New York Central's men simply went over the train pipes to stop any leaks, and did no cleaning or oiling.

Standing Tests.—The standing tests of the New York brake were made on Sept. 8 and those of the Westinghouse on Sept. 10. The running tests were made on Sept. 9. For the standing tests each train was arranged in two sections of 25 cars each upon parallel tracks, and the sections were connected by about 30 ft. of 1¼-in. pipe, with hose and couplings at each end. This brought Mr. Dudley's dynagraph car, in which autographic records of the tests were made, directly opposite the locomotive.

Tests No. 1, 2, 3, 4 and 5 were designed chiefly to ascertain the condition of the train pipe with respect to tightness. No observations of these tests were recorded, except that the train pipe of each train was found to be in good condition and free from any important leaks.

Test 6 was made to determine the time which elapsed between the movement of the engineer's valve and the development of pressure in the first car and the fiftieth car. It was repeated three times. Fig. 1 will serve to illustrate the method by which the results of this test were secured.

The recording apparatus in Mr. Dudley's car was arranged to cause a tape about 2 ft. broad to travel at a practically uniform velocity. Upon this tape the different records were made automatically by pens. Two of these were connected with ordinary steam engine indicators, the pipes of which led to the brake cylinders; and others were connected to electro-magnets, as explained below. The different figures have been somewhat drawn together in Fig. 1 to economize space; but the diagrams in this figure are fairly representative of the character of all the diagrams taken for each brake. In this figure, line 4 is drawn by the pen connected by electric circuit with the engineer's brake valve, so that at the instant that he applies the brake, a jog will appear in the line. Lines 5 and 6 are drawn by pens controlled by electric circuits leading to a clock. The jogs in line 5 occur every 10 seconds, and those in line 6 occur every second. Line 1 is the base line of the diagram of the performance of the brake cylinder upon the car. Line 2 indicates the train-pipe pressure at the forward end of the train just prior to the experiment, the indicator having been connected to the train pipe for this purpose. Line 3 is the pressure line for the cylinder of the first car during the experiment. Line 7 is the base line of the diagram of the cylinder upon the 50th car. Line 8 indicates the train-pipe pressure at the rear end of the train just prior to the experiment, and line 9 is the pressure curve for the cylinder of the 50th car. In our reproduction the ordinates of the diagrams are on a scale of 144 lbs. to the inch. Of course the base lines 1 and 7 and the lines 4, 5 and 6 are all parallel. On cutting the line 6, by perpendiculars passing through the points indicating the time of application by the engineer on line 4, the points of initial entrance of air to the cylinder of the first car and the time of full application in the cylinder of first car, and also the points of initial entrance and full application of air in the cylinder of last car, the difference in time between these events may be readily ascertained.

This description applies equally to the diagrams of either brake.

For convenience of reference and to further economize space the base lines of the diagrams of the cylinders of the 1st and 50th cars are moved to coincide, and the lines 4, 5 and 6 are not shown in Fig. 2, the measurements being only indicated by letters and tabulated below.

Table I.—Rate of Application of Brakes on 50-Car Trains, Standing Test, Engineer's Valve in Emergency Position.

Brake	No. of trial.	Time in Seconds: Movement of engineer's valve to entrance of air, 1st brake cyl. (A.)	Entrance of air to full pressure, 1st brake cyl. (B.)	Entrance of air, 1st brake cyl., to entrance of air 50th brake cyl. (F.)	Entrance of air, 50th brake cyl., to full pressure, 50th brake cyl. (L.)
Westinghouse	1	.30	1.60	2 60	.90
"	2	.29	1.60	2 60	.90
"	3	.30	1 60	2.55	.90
New York	1	.25	3.35	3.13	2.82
"	2	.24	2.16	3.06	2.50
"	3	.28	2.92	3.02	2.90

In Fig. 2 the vertical line at the left denotes the instant of the application of the brakes by the engineer's valve. The curve next to the right is that of the cylinder of the first car and that further to the right is the curve of pressure in the 50th brake cylinder. The time elapsing between the application of the brakes by the engineer's valve and the initial entrance of air in the brake cylinder of the first car is represented by the distance A. The time elapsing from the initial entrance of air to full pressure in the cylinder of the first car is denoted by B. The time elapsing from the initial entrance of air into the cylinder of the 1st car to the initial entrance of air into the cylinder of the 50th car is represented by F, and that elapsing between the initial entrance and full pressure of air in the cylinder of the 50th car is denoted by L. There were three trials of each brake in test 6, the results of which were as shown in Table I. Test 7 was the same as the preceding with the exception that the brakes on these cars, the fifth, sixth, and seventh, were cut out. This test was to be made three times for each brake. In the case of the Westinghouse brakes the jump was accomplished and the brakes promptly applied in each trial. The New York brakes applied the first time, but failed to apply in the second and third trials. They were then given a fourth trial and again failed. In a fifth trial they were again successful in jumping the cut-out brakes and applying throughout the train. The results are given in Table II.

Table II.—Rate of Application of Brakes on 50-Car Trains, with Three Cars Cut Out.

Brake.	No. of Trial	Time in seconds: Movement of engineer's valve to entrance of air, 1st brake cylinder (A.)	Entrance of air, 1st brake cylinder to entrance, 50th brake cylinder (F.)	Remarks.
Westinghouse	1	.20	2.60	.....
"	2	.20	2.70	.....
"	3	.22	2.70	.....
New York	1	.20	3.70	.....
"	2	....	....	Failed to apply.
"	3	....	....	" "
"	4	....	....	" "
"	5	.25	4.20	.....

Test 8 was made the same as Test 7, except that six cars instead of three (the fifth to the tenth, inclusive) were cut out. This was tried on the Westinghouse train, and in each case the quick-action failed to jump the cut-out cars, and the application did not extend throughout the train. The test was not tried on the New York train.

Test 9 was a graduation test. A reduction of 8 lbs. in train-pipe pressure was made; then, at one minute intervals, successive reductions of 4 to 6 lbs. were made until reservoirs and cylinders were equalized. No complete record of this test is obtained. The 50 Westinghouse brakes applied at the first reduction of 3 lbs., in each trial. The cylinder pressures increased with each subsequent reduction of train-pipe pressure until the pressures in the brake cylinders and reservoirs became equalized. The New York brakes did not all apply at the first reduction of 8 lbs. In one trial 12 brakes refused to apply. During the subsequent reductions some of these applied. In one trial 4 are known to have not applied at all, even after the reductions were made, while others had leaked off.

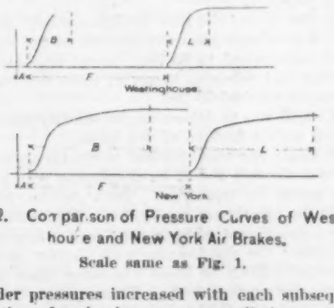


Fig. 2. Comparison of Pressure Curves of Westinghouse and New York Air Brakes.
Scale same as Fig. 1.

Test 10 was another graduation test. No records of its results are obtained.

Test 11 was a leak-off test. It consisted of an emergency application, the train pipe being left open to the atmosphere, and at the end of 30 minutes the number of brakes which had leaked off was noted. With the Westinghouse train 4 brakes leaked off. One of these was upon the 50th car and connected to the dynagraph car by pipes which were not tight and caused the leakage. The blowing out of a portion of the rubber gasket between the cylinder and reservoir of another brake caused the air to quickly escape.

In the test of the New York train, the brakes were properly applied; but, at some later time, the handle of the engineer's valve was turned to the lap position, by some unauthorized person, thus closing the end of the train pipe and allowing the air which leaked back into it through the triple valves to collect. The engineer subsequently discovered that a pressure of 16 lbs. had accumulated in the train pipe, and he turned the handle of the engineer's valve again into the emergency position. The brakes, which had before this leaked off, applied again. While this accident thus furnished the information that the brakes were leaking off through the triple valves, it prevented a proper determination of the number of brakes which would leak off in 30 minutes. As it was, the number which had gone off at the end of the 30 minutes was 14.

In test 12 the train pipe was emptied by an emergency application; air was then allowed to pass into it through a 3-32-in. hole in a ⅛-in. diaphragm from a reservoir maintained at 90 lbs. pressure, and the time of release of the brakes was noted.

The object of this test is two-fold; (a) to determine the certainty of release and (b) to test the brakes for tightness. With the emergency application the brakes are set with about 60 lbs. pressure, and if there is no leakage in the train-pipe, the train-pipe pressure must be raised to about 61 or 62 lbs. to cause release to take place. On the other hand, if the brakes leak down to a lower pressure, then a lower pressure will be required in the train-pipe to effect release. For instance, if the brake releases at 12 lbs. train-pipe pressure, it shows that the brake had leaked down to 10 or 11 lbs. Hence the leakage is directly indicated by the pressure at which release takes place. The lower the pressure of release, the greater is the evidence of leakage, and the more rapid the leakage the easier is release accomplished. If the brakes leak rapidly enough, they will release themselves without a raise of train-pipe pressure. This was shown in the case of a brake which had a fractured gasket between the reservoir and cylinder.

In the test of the Westinghouse train, there were three brakes which failed to release when the train-pipe pressure was raised to 63 lbs. Of those which released, three went off quickly and at low train-pipe pressures. One of these had the fractured gasket and the other two were those connected by leaky pipes to the recording apparatus. None of the remainder released below about 50 lbs. train-pipe pressure.

In the test of the New York train only one brake failed to release after the pressure in the train pipe had been raised to 63 lbs. About one-half of the brakes had released, however, when the train-pipe pressure reached 30 lbs.

Test 13 was to determine the sensitiveness of the quick action feature of the brake.

A single car was attached to the locomotive, and a vent through a 5-32-in. diaphragm was given to the air in the train-pipe. Both brakes went on with the emergency application. This showed that the arrangement of apparatus was defective; that is, either the diaphragms were larger than the specified 5-32-in. or there was some other unusual cause for such action. This appears from the fact, that the 5-32-in. diaphragm was chosen by the M. C. B. Committee as one that should not permit a brake to go on with the emergency application in service work, it having been ascertained that this size of diaphragm will not allow the Westinghouse brake to go on with the emergency, when the diaphragm is accurately made and properly arranged. This fact makes test 13 of little or no practical value.

Test 14 was to determine the length of time necessary to charge the auxiliary reservoir on one car, but it furnished no useful information as to either brake, owing to the considerable leakage from the reservoirs through the pipe connections to the recording apparatus. This leakage was so great that the noise of the escaping air could be distinctly heard by observers of the tests. The feeding-in port of the triple valve, through which the air passes to the reservoir, is exceedingly small, and any leakage from the reservoir which could be perceived by the ear, is of sufficient magnitude to destroy all practical value in the results.

Deductions from the Standing Tests as to Rate of Application of Brakes.—Some striking facts, both interesting and useful, were brought out by the apparatus used in these tests. The use of the indicator gives accurate and instructive information concerning what takes place in the brake cylinders during the period of application of the brakes. There is but one apparent error introduced into the results of the standing tests, which affects only the length of time elapsing between the initial entrance of air into the cylinders of the 1st and 50th cars. This error is principally due to the use of the extra length of pipe and additional hose and couplings inserted between the 25th and 26th cars. In test No. 6 the average time between the entry of air to the brake cylinders on the first car and on the 50th car (F) for the three trials of the Westinghouse brake is 2.58 seconds, while that of the New York brakes is 3.07 seconds. During the running tests of the train, when the unusual length of pipe between the 25th and 26th cars was removed, an electric chronograph upon the Westinghouse train gave the average time elapsing between the application of the brakes at the 1st and 50th cars as 2.43 seconds. This indicates that the time F, for both 50-car trains, as shown in the standing tests, was 0.15 seconds greater on account of the extra length of pipe. Making corrections for this error, the average times of application would become for the Westinghouse train, 2.43 seconds, and, for the New York train, 2.92 seconds. The time of application with the New York brake is therefore more than 20% greater than that with the Westinghouse brake, and, so far as may be judged from past experiments, this increased time of application with the New York brake is wholly sufficient to account for the large shocks to which the New York train was subjected in the running tests.

A fact of great importance was also reported in test No. 7. By comparing the average of the times of application (F) in the three trials of the Westinghouse brake in test No. 7, with the average in test No. 6, it will be seen that the former, where three consecutive brakes were cut out, was only 0.09 seconds greater than the latter. While the New York brake entirely failed to apply in three trials out of five, it will be observed that the time of application (F), in the first trial of test No. 7, exceeds the average of the times in test No. 6 by 0.63 seconds, and, in the fifth trial of test No. 7, it exceeds the average of test No. 6 by 1.13 seconds.

It cannot be doubted that very great shocks would occur upon a 50-car train, with brakes which consumed such a long time in application as was recorded in test No. 7 of the New York brakes. In view of the discovery of this greatly increased time of application, when some brakes are cut out, it would seem to be very important that in future brake trials, running tests with two and with three consecutive brakes cut out of service, should be made. The Master Car Builders' Committee have stipulated that brakes must be susceptible of sure application with three consecutive brakes cut out; but it would appear to be equally important that with three consecutive brakes cut out the brakes may be applied without destructive results to the train or its lading.

In addition to the information in regard to the length of time elapsing between the initial entrance of air into the cylinder of the first car and of the last car, the indicator diagrams also show a very considerable difference in the length of time required in the two brake systems to acquire full cylinder pressure after the air has begun to enter the cylinder. This matter also has an important bearing on the behavior of the brakes. If the brakes could be at once applied with full pressure, the greatest retarding effect would be brought upon the train; and the nearer the approach to such an application of the brakes, the better the results will be. To compare the two brakes in this respect we may proceed in the same manner as we would to find the mean effective pressure in a steam engine cylinder from the indicator card. Thus, in Fig. 3, the effect on the brake piston from the initial entrance of the air to the time when full pressure is attained is the same as if the full pressure had been instantly attained at some intermediate time. Referring to Fig. 3, it was found that the resistance of the release springs, together with the frictional resistance of the brake gear, was sufficient to require a pressure of 5½ lbs. in the cylinder to move the brake shoes so that they came into contact with the wheels. In each one of the indicator diagrams there is therefore drawn a horizontal line, at a height corresponding to 5½ lbs. above the base line. The point at which this line cuts the pressure curve determines the instant at which the brake shoes come into contact with the wheels. At the right from this point on the 5½-lb. line, is laid off a convenient distance, corresponding to a sufficient length of time to reach beyond the point where full pressure is realized in the cylinder. At the right end of this line, is drawn a vertical line to the pressure line. The area of the figure inclosed by this vertical line at the right, the 5½-lb. line and the pressure curve is then ascertained. The quotient of the area thus found, divided by the length of the vertical line at the right, is the base of a rectangle laid off to the left from the vertical line mentioned, which incloses an area equal to that of the original diagram. In other words, the work done in retarding the car would be the same if the brakes had been instantly applied, and the vertical dotted line through the pressure curve were substituted for that curve. The line E then represents the interval of time which would elapse after the movement of the engineer's valve to an instantaneous full application of the brakes on the first car, equivalent in retarding force to the gradual application which actually occurs. In like manner, the line K represents the time elapsing from the movement of the engineer's valve to an instantaneous application of the brake on the rear car. Since the applications of the brakes to the cars intervening between the 1st and 50th occur in uniform succession at regular intervals, the

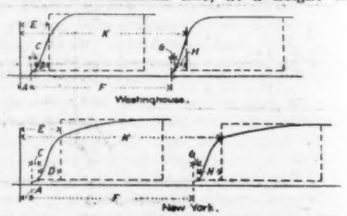


Fig. 3. Comparison of Pressure Curves, Showing Point of Instantaneous Application Equivalent to the Gradual Application.
Scale same as Fig. 1.

Table III.—Rate of Application of Brakes on 50-Car Train. (See Fig. 3.)

Time in seconds from:		Westinghouse Tests. 1	2	3	New York Tests. 1	2	3
Engineer's valve opening to entrance of air, 1st brake cyl	A	.30	.20	.20	.25	.24	.28
Entrance of air, 1st brake cyl. to 5½ lbs. pressure	C	.09	.09	.08	.15	.14	.15
5½ lbs. pressure, " " " to equivalent instantaneous application	D	.26	.26	.23	.62	.54	.49
Engineer's valve opening to equivalent instantaneous application, 1st brake cyl.	E	.65	.55	.51	1.02	.92	.92
Entrance of air, 1st brake cyl. to entrance 50th brake cyl	F	2.45	2.45	2.40	2.98	2.90	2.97
" " " 50th " " " to 5½ lbs. pressure	G	.05	.06	.05	.05	.05	.07
5½ lbs. pressure, " " " to equivalent instantaneous application	H	.22	.21	.23	.54	.50	.51
Engineer's valve opening to equivalent instantaneous application, 50th brake cyl	K	3.02	2.91	2.88	3.82	3.70	3.73
Engineer's valve opening to mean equivalent instantaneous application on 50-car train	Mean of E & K	1.835	1.73	1.695	2.42	2.31	2.325

mean of the times E and K is therefore that length of time which would elapse between the application of the brakes by the engineer's valve and an instantaneous full application of the brake upon every car of the train, which would produce the same retarding effect upon the train as that which was produced by the successive, gradual applications of the brakes throughout the train.

The areas of the diagrams taken from the cylinders of the first and last cars of each train, in each trial of test No. 6, were accurately measured and the results are shown in Table III.

It is to be noted that the interval F, between the initial entrance of air into the cylinder of the first car and that in the cylinder of the last car, has in each case been corrected by the subtraction of 0.15 seconds from the times F shown under test No. 6. It may also be further noted that the times D and H are those which depend upon the above explained calculations, all others having been directly measured upon the original diagrams.

The average of the mean times found in Table III., for the three trials of each brake, gives an interval between the application of the brakes by the engineer's valve and an equivalent instantaneous full application, upon the whole Westinghouse train, of 1.75 seconds, and, upon the New York train of 2.35 seconds. That is, a stop of the New York train must necessarily, from this cause, be longer than that of the Westinghouse train, by a distance equal to the product of the difference between these average times (0.6 seconds) and the speed, in feet per second, at which the trains are running when the brakes are applied. The chief value of the knowledge of these times for equivalent instantaneous full application is their application in the formula for the correction of the lengths of stops, made in running tests, for train-pipe pressure and for speed. Hitherto these times could not be established, because of a lack of just such data as these diagrams furnish, and these times have had to be approximated.

If s_1 is the length of stop, V_1 the speed in miles per hour and P_1 is the train-pipe pressure, actually occurring under a given set of conditions, and s is the corresponding length of stop, for a speed of V miles per hour and a train-pipe pressure of 70 lbs., it is readily shown that where the stop is made upon a level track (as was the case at Karners),

$$s = \frac{P_1 - 2}{68}(s_1 - 1.47\ t\ V_1)\frac{V^2}{V_1^2} + 1.47\ t\ V.$$

In this formula, t is the average time of instantaneous full application above found, and its value differs for different systems of brakes and for different lengths of trains of the same system of brakes. As the value of t has now been determined for 50-car trains of both the Westinghouse and New York brakes, this formula permits of very accurate reductions of the results of the running tests and a more accurate comparison of the stops than has been possible hitherto.

The Running Tests.—The provisions for automatic record of the action of brakes in the standing tests were deserving of much praise; but the arrangements for making the running tests were even farther in advance of anything ever before accomplished in a brake test. The two 50-car trains were run side by side on parallel tracks at uniform speed, and the track where the stop was made was a dead level.

A signal was placed at the point where the brakes were to go on, and as the engineers reached it the locomotive throttles were closed. The brakes were applied automatically by a tripping block which opened wide the train pipe and applied the brakes at exactly the same point on both trains. In the dynagraph car the speed of the train, the application of the brake and the curves of brake cylinder pressure were automatically recorded. Thus all questions of grade, speed, condition of the rail, difference in condition of the brake gear and error on the part of the engineer were eliminated. The only variation in conditions appears to be that of the train-pipe pressure, correction for which is readily made.

Not only were the arrangements admirable, but the weather was such as to favor the working of the brakes, the rail being in first-class condition. The accuracy of the results seems to be above suspicion in all cases, except that of running test 4.

There were 7 running tests. The first 4 were emergency stops of both trains, running side by side. The 5th was a stop made through a full service application of the brakes on both trains, the air being allowed to escape from the train pipe through as large an opening as possible, without causing an emergency application of the brakes, the opening being in a diaphragm so that the same reduction was insured on the two trains. Stops 6 and 7 were to have been made by single trains, each made up of 25 Westinghouse brakes and 25 New York brakes, intermixed so that five consecutive brakes were of one system, the next five of the other system and so alternating throughout the train. By some error, in shifting the cars to make up these two trains, that which was used in test 6 consisted of but 45 cars, and that used in test 7 consisted of 55 cars.

Tabl IV.—Results of Running Tests.

Brake.	No. of Stop.	Train-pipe pressure, lbs. p r sq.in. Front.	Rear.	Speed m. per hr.	Distance of stop. ft.	Slidometer. movements. ins. Front car.	Rear car.
Westinghouse.	1	68	68	26.78	270	+ ¼	+ ¾ 4
"	2	58.5	68	32	373	+ ¾	+ ¾ ½
"	3	64.5	65	34.48	472		+ ½ ½
"	4	70	71	31.39(7)	325	0	6
"	5	68	68	28.39	841	0	3
New York.....	1	71	71	26.73	310	+ 1¾	26¼
"	2	71	70.5	32	450	+ ⅛	+ ¾ 31
"	3	69	70	34.48	496	+ ⅛	+ ⅛ 28¼
"	4	65	63	31.88(7)	417	+ ⅜	26⅛
"	5	70.5	70.5	28.39	957.5	+ ⅜	1¼
Mixed.....	6	65	63	27.75	325	0	10¾
"	7	72	70	30	344	+ ¼	+ ¾ 23½

Note.—In No. 3 stop, Westinghouse train parted between card 6 and 7, and became separated by a distance of 34.8 ft. In the same stop, the New York train parted between cars 12 and 13, and became separated by a distance of 38 3 ft. In stop No. 4, both trains parted and were separated by distances not noted. In stops 6 and 7 the train parted (in two places in No. 6) and a small separation occurred.

Table IV. shows the results of the running tests.

In order to make the lengths of stops exactly comparable, it is necessary that the equivalent length of stop for the standard train-pipe pressure of 70 lbs., and a particular speed, should be found for each of those which took place. The standard train-pipe pressure is 70 lbs., and, in making these reductions, the train-pipe pressure indicated for the front end of the train is used, being considered the most reliable. The speed chosen as being the nearest to an average is 30 miles per hour, and the lengths of all emergency stops are reduced to this speed.

The formulas for making these reductions are made up from that given above as follows:

For Westingh'se train, $s = \frac{P_1 - 2}{68}(s_1 - 2.57\ V_1)\frac{900}{V_1^2} + 77.1$

For New York train, $s = \frac{P_1 - 2}{68}(s_1 - 3.45\ V_1)\frac{900}{V_1^2} + 103.5$

For mix'd tr'n (45 cars), $s = \frac{P_1 - 2}{68}(s_1 - 2.85\ V_1)\frac{900}{V_1^2} + 85.5$

For mix'd tr'n (55 cars), $s = \frac{P_1 - 2}{68}(s_1 - 3.24\ V_1)\frac{900}{V_1^2} + 97.2$

It is necessary to make corrections for the distance of each train in stop No. 3, on account of the parting of the train. Where the distance is measured at the head end of the train, a break-in-two will cause the forward section of the train to travel farther than it would have done if it had remained attached to the rear end, on account of the smaller proportion of braking force on the forward section, due to the unbraked weight of the locomotive. The effect of such parting of the train upon the forward end depends, therefore, upon the relative proportions of the train in the forward and rear sections. It is readily demonstrated that the correction to be subtracted from the distance, as measured at the forward end of the train, is equal to the product of the interval of separation between the two sections and the total braking force upon the rear section of the train, divided by the total braking force of the whole train.

Table V. shows the results of corrections for parting of train, train-pipe pressure and speed.

As before stated, there should have been a correction in stop No. 4 of each train, on account of the separations of the trains, but proper notes of the separation were not made. The speeds of the two trains were different in this stop, it being the only stop in which any question of differences of this kind arose. The first speeds deduced by Mr. Dudley were as shown by the upper figures in the bracket. The reduction of these stops to a speed of 30 miles per hour and the proper train-pipe pressure would indicate a very considerable discrepancy between the results of stop No. 4 and the averages of the other three emergency stops. This discrepany would be increased if a proper correction were made for the parting of the trains. Had the speeds been 30.4 miles per hour for the Westinghouse train and 30.9 for the New York train, the stops, reduced to 30 miles an hour, would still have been below the average of the other three, for both trains. Mr. Dudley considers that the recorded speeds are not reliable, and therefore the distances found for test No. 4 are thrown out and do not influence the averages found below.

The shocks in the forward car of each train were uniformly very light. Those which occurred caused a forward movement of the slidometer. In some cases two separate forward movements occurred; but, as will be seen by reference to the table, all were insignificant and merit no further considera-

Table V.—Results of Emergency Stops in Running Tests Reduced to Uniform Speed and Train-Pipe Pressure and Corrected for Separation of Train.

Brake.	No. of stop.	Distance of Stop.	Dist. cor. for separation of train.	Train-pipe pressure.	Dist. cor. for pressure.	Speed.	Dist. reduced to 30 miles per hour.
		Ft.	Ft.	Lbs.	Ft.	M.p.h.	Ft.
Westinghouse..	1	270	...	68	264.1	26.8	321.7
" ..	2	373	...	68.5	366.6	32	327
" ..	3	472	444	64.5	415.3	34.5	324
" ..	4	325	...	70	325	{31.4 / 30.4}	{300.1 / 317.5}
New York	1	310	...	71	313.2	26.8	380.1
"	2	450	...	71	455.6	34	402.4
"	3	496	470	69	464.8	34.5	365
"	4	417	...	65	394.4	{31.9 / 30 9}	{355 / 374.6}
Mixed.....	6	325	...	65	306.9	27.75	351.7
"	7	344	...	72	351.3	30	351 3

tion. The shocks at the rear end of the trains were quite different. With the Westinghouse train they were light, the maximum in the four emergency stops being 6 ins., and the average 2¾ ins. In the New York train the shock was very heavy for every emergency stop, the minimum being 26½ ins. and the average 28.17 ins. The shocks at the rear of the mixed trains, as would be expected, differed considerably, that of the 45-car mixed train being but 10¾ ins., while that of the 55-car train was 23½ ins. The difference in these shocks would be, to a considerable extent, due to the differences in the lengths of the train. The average of the mixed train shocks is 16⅞ ins.

The following table shows the averages of the lengths of emergency stops, for a speed of 30 miles per hour, of each train, and the averages of the shocks of each.

Brake.	Speed. m. p. h.	Distance of stop. ft.	Slidometer movement. ins.
Westinghouse....	30	324.2	2 3-4
New York.....	30	383.8	28 1-16
Mixed.....	30	351.5	16 7-8

These averages may be taken as fairly representative of the efficiency of the brake system in each case.

It will be noted that, at 30 miles per hour, the New York train requires 59.6 ft. farther distance in which to stop, which is 18.4% of the whole length of stop of the Westinghouse train. It would naturally be expected that if such a difference in the performances of the two brake systems exists, the mixing up of the two systems in a train would produce results as to length of stop and shock, intermediate between those found for each train separately.

It is not a little interesting, therefore, to compare the average of the results of the Westinghouse and New York trains with the results from the mixed trains. The average of the distances of the Westinghouse and New York trains is 354 ft.; the mean distance of the mixed train stops was 351.5 ft.; the average of the shocks of the Westinghouse and New York trains is 15⅝ ins. and the average shock of the mixed train is 16⅞ ins. In this manner, the results check one another admirably, and give further emphasis to the reliability of the results found.

To remove any question of difference in conditions on account of difference in locomotives, after emergency stop No. 3 the locomotives were changed so that the one which had been hauling the Westinghouse train during the first three stops, hauled the New York train during the 4th and 5th stops, and vice versa. It will be observed that the rela-

tions between the stops of the two trains did not appear to be in any wise affected by the change.

The results of stop No. 5, with a full service application, are somewhat remarkable. The New York train traveled, in making this stop, 113.5 ft. farther than the Westinghouse train, although the Westinghouse train had a pressure of but 68 lbs. in the train pipe, while the train-pipe pressure of the New York train was 70½ lbs. There is no data at hand by which an accurate reduction of the lengths of service application stops can be effected, and it is therefore impossible to show the exact relation of the stops of the two trains. It is evident, however, that with the train-pipe pressure of the New York train, the Westinghouse train would have stopped in a shorter distance.

A New England surface railway syndicate with a capital of $5,000,000, which may be raised to $50,000,000, has been organized under the name of the New England Street Railway Co. The certificate of incorporation, filed at Trenton, N. J., gives the new company power to enter into almost every line of business, and the Board of Directors includes the names of the presidents of many important New England banks and street railway companies. Maj. A. C. Pond, of Boston, is to be the president. Rumor has it that the company is soon to control every surface railroad of importance in New England. But the charter also enables the company to do business in any other state or territory of the United States, or in Montreal, in England and France and in the Argentine Republic.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

MANCELONA & NORTHWESTERN.—This company now has four miles of railway completed, and will build two miles more this season. Ultimately the road will be 10 miles long. Pres., W. H. Thompson, Mancelona, Mich.

TIONESTA VALLEY & HICKORY.—The line from Nebraska to Ross Run, Pa., 5 miles, has been graded and track will be laid this spring. Pres. and Ch. Engr., T. D. Collins, Nebraska, Pa.

OLD COLONY.—The Boston "Journal" states on what it claims to be authoritative information that this company will expend $7,000,000 in terminal improvements at Boston. The principal of the proposed improvements are stated to be as follows: The elevation of the Providence Division track as far as Forest Hills and laying of a four-track line, another train house and a change in the location of the freight houses at the Park Square station. This to cost perhaps $3,000,000. The elevation of tracks at West Fourth St., South Boston, and the use of nine acres of land there for new freight yards. The removal of the Kneeland St. freight yards and the building of a more commodious passenger station. The station costing perhaps $500,000, the whole changes not far from $3,000,000. The doing away with 15 grade crossings at Brockton at a probable cost of $1,000,000. The probable building of a connecting loop line of tracks from Mattapan to Clarendon Hills, the probable expense of which is not yet determined fully.

PITTSBURG, AKRON & WESTERN.—It is stated that work will begin in the early spring upon the Akron & Eastern R. R., from Akron, O., to New Castle, Pa., 70 miles.

PHILADELPHIA & READING.—There is talk of a branch being constructed from reading to Bernville, Pa., 14 miles.

Projects and Surveys.

INDIANAPOLIS, LOGANSPORT & CHICAGO.—This road is projected to run from Indianapolis, Ind., to Chicago, Ill., 187.6 miles. It is intended to begin work at once on the section from Indianapolis to Logansport, Ind., 70.6 miles, and to have it completed by Aug. 1, 1893. The right of way for this portion of the line has been obtained, including terminals at Indianapolis and Logansport, and liberal subsidies granted. Pres., Edward N. Talbott, Logansport, Ind.

WHEELING & CONNELLSVILLE.—This railway has been surveyed from Wheeling, W. Va., to Uniontown, Pa., 75 miles, and will probably be put under construction this year. Ch. Engr., Job. Abbott, 150 Broadway, New York, N. Y.

Southern.—Existing Roads.

WEKIVA, BRONSON & NORTHEASTERN.—Ch. Engr. Chas. P. Turner, Judson, Fla., writes us that this company has under consideration an extension from Bronson, Fla., via Judson, Trenton, and Frankland, to High Springs, Fla., 52.5 miles. Of this 31 miles from Bronson, Fla., to the Suwannee River has been surveyed. The road is being built in the interest of the Suwannee River Phosphate Co., and the amount of new line built this year will depend upon the price of phosphate, which furnishes the principal traffic for the road.

GULF RED CEDAR CO.—This company has six miles of road completed and will build six miles more this season. Sufficient 35-lb. or 40-lb. rails are needed for this extension. Pres., W. H. Parrish, Greenville, Ala.

HODGENSVILLE & ELIZABETHTON.—The engineer in charge of the surveys for this line from Hodgensville to Scottsville, Ky., has made a favorable report and it is probable that work may soon be commenced. The road is practically a branch of the Chesapeake & Ohio Southern Ry.

TENNESSEE, ALABAMA & GEORGIA.—This is the name of a proposed new system of railways which, it is reported, is now being formed in the South. The roads to be included in the system are: the Chattanooga Southern R. R., 86 miles; the Marietta & North Georgia R. R., 244 miles; the Knoxville, Cumberland Gap & Louisville R. R., 81.8 miles; Morristown & Cumberland Gap R. R., 40 miles; Georgia Southern & Florida R. R., 285 miles; Macon & Birmingham R. R., 97 miles; Macon & Atlantic R. R., 200 miles, not built. The total mileage of the above lines is 1,034.

LOUISVILLE & NASHVILLE.—This company will at once let the contract for the construction of a 12-mile branch up Clear Creek in Kentucky.

Projects and Surveys.

FLORIDA.—Charter for the Atlantic Coast & Gulf R. R. Co. will be applied for next month. The company proposes to build a railway from a point at or near Cape Canaveral, in Brevard Co., through Osceola, Polk, Hillsboro and Manatee counties to some point on the Gulf coast near Terra Ceia Island, with a branch to extend from the main line in Osceola Co. through Orange, Lake, Sumter, Citrus, Marion, Levy, Alachua, Lafayette, Taylor, Jefferson and Leon counties to Tallahassee. The officers are: Eugene Ellery, Pres.; Wm. Van Fleet, Vice-Pres. and Sec., and Richard R. Foote, Treas. The above, together with Ellesworth Hewitt and J. J. Henderson, will be the directors.—Charter is to be applied for for the Tampa & Northern Ry. Co., purposing to build a railroad from Tampa to Owensboro, a distance of about 40 miles. Jas. H. Neff is Pres., N. P. Baker, Vice-Pres., and D. L. Powe, Secy. and Treas., and they, with Frank Scott and G. C. Hayes, will be the directors; capital stock $100,000.

NORTH CAROLINA.—Bills to incorporate the Blowing Rock & Lenoir Ry. Co. and Atlantic, Yanceyville & Reidsville R. R. Co. have been introduced into the state legislature.

ALABAMA.—A bill incorporating the Mobile & Spring Hill Ry. Co. has passed the legislature. A bill to incorporate the Dauphin Island & Moss Point R. R. Co. has been introduced in the legislature.

Projects and Surveys.

RICE LAKE, DALLAS & MENOMINEE.—The officers of this company, noted last week, are: Pres., S. C. Olmstead, St. Paul, Minn.; Vice-Pres. and Ch. Engr., H. E. Clark, St. Paul, Minn., and Secy. and Treas., J. E. Horseman, Rice Lake, Wis.

Southwest.—Existing Roads.

MISSISSIPPI RIVER AND NORTHWESTERN.—This Arkansas railway will, it is stated, be extended to Pendleton, Ark. The road is now nine miles long, and does a freight business only.

Rocky Mountain and Pacific.—Existing Roads.

COLUMBIA RY. AND NAVIGATION CO.—The Seattle "Post" says: "The portage railway along the north bank of the Columbia River, around the obstructions to steamer navigation at The Dalles, the contract for completing which was recently let to McKenzie & Glynn, of Spokane, will be about 22 miles long from Columbus to Crates Point. About six miles of the grading, comprising the heaviest rock, has been finished, but on account of heavy snows work has been suspended temporarily, but will be resumed as soon as the weather will permit. Three miles of track has been laid, and the rails for the entire line have been purchased. The character of the work is exceedingly difficult, almost the entire line being in solid rock, as the line skirts the base of the basaltic cliffs or palisades, flanking the Columbia River at these points. The maximum grade is less than 1%, and the maximum curve 9°. On the section now being completed there is one tunnel about 250 ft. long and one trestle about 800 ft. long and 80 ft. high, and a few small trestles. The money thus far expended has been furnished by a construction syndicate which will furnish the money to complete the work. The first mortgage bonds of the company will not be offered for sale until this section of the road is completed. The amount expended to date is as follows: For right of way and lines, $64,272; franchises and rights from other companies, $67,276; engineers' expenses, $12,183; construction, $250,294; rails and fastenings, $101,191; total, $495,216. The amount required to complete the 22-mile section to be used as a portage railroad is $315,000; the cost of river equipment, consisting of steamers and barges, will be $400,000; the cost of the line from Portland to Walla Walla will be $5,400,000, including the 22 miles now being completed; the cost of branches to be completed within three years, about $1,800,000. The officers of the company are: Pres., A. M. Cannon, Spokane, Wash.; Vice-Pres., J. Lowenberg, Portland, Ore.; Secy., Paul F. Mohr, Tacoma; Chf. Engr., Emery Oliver, The Dalles, Ore. Mr Mohr has an office at 45 Broadway, New York, N. Y."

Foreign.

MEXICAN INTERNATIONAL.—A press dispatch from Monclova, Mex., gives the following information in regard to the extension from Monclova to Sierra Mojada: "The construction work is in charge of W. T. Robertson, who states that his forces have graded the stretch to the city of Cuatro Cienega, 160 miles from Monclova, and within the last few weeks have carried the work of grading 30 miles beyond into a mountain gap called Puerto Jora. Here grading has stopped pending orders from headquarters. A party of engineers is now at work locating the remainder of the line from Puerto Jora to Sierra Mojada. No tracklaying has been done, save a little in the yards at Monclova; but ties and rails are fast piling up at the starting place, there being about 50 miles of material now on hand. Mr. Robertson expects to begin the active work of laying the track in March. The stretch into Sierra Mojada will also be graded, and by next July, if all works well, the contractor hopes to run locomotives into the town of Sierra Mojada. The extension will open a fine region of country. For 30 miles, on the stretch to Cuatro Cienega, along the Salado River, are vast plantations, or haciendas, one adjoining the other. Then comes the rich fruit country of Cuatro Cienega, which is also the shipping point for a number of valuable mines close by. After leaving Cuatro Cienega, the road traverses a desert stretch until it reaches the fertile and sheltered spots in the heart of the Sierra Mojada Mountains. This city is one of the most thriving places in Northern Mexico. There is here an endless supply of silver which can be easily secured. Several large mines are in operation, and some 70,000 people have located there within the past few years.

ELECTRIC RAILWAYS.

GREENWICH, R. I.—The Greenwich & Warwick Ry. Co. is to be chartered to build an electric railway from Greenwich to Warwick, R. I. Capital stock $250,000. Incorporators, Jos. Dews, Wm. G. Browning, Wm. P. Sharpe and others.

WILMINGTON, DEL.—A bill is before the Delaware Legislature chartering the Wilmington Electric Ry. Co.

CINCINNATI, O.—The Cincinnati & Dayton Electric Ry. Co. is to be organized to build an electric railway from Cincinnati to Dayton, O. Incorporators, Andy Hickenlooper, L. C. Weir, Wm. A. Goodman and S. M. Felton.

WAYNESBORO, MD.—There is talk of an electric railway from this place to Glen Mar, Md., 4½ miles.

ALBION, MICH.—A company has been formed with a capital stock of $25,000 to build an electric railway.

HARRISBURG, PA.—Chartered, Harrisburg & West Side Ry. Co.; capital stock, $100,000; Pres., Chas. B. McCawley.——Chartered, Fairview & Riverton Passenger Ry. Co.; Fairview to Riverton; capital stock, $50,000; Pres., Henry McCormick.

MARSHALLTON, PA.—Chartered, Citizens' Passenger Ry. Co., of Chester Co.; West Chester to Marshallton; capital stock, $80,000; Pres., Thos. Pennypacker.

OSBORN, PA.—Chartered, Sewickley Valley Passenger Ry. Co.; Bellevue to Sewickley, Pa.; capital stock, $100,000; Pres. F. J. Feuer.

READING, PA.—Chartered, Pottstown, Boyertown & Reading Ry. Co.; Pottstown to Reading; capital stock $150,000; Pres., Jas. B. Craighead.

PHILADELPHIA, PA.—Chartered, Moore & Mifflin Sts. Passenger Ry. Co.; 24th and Moore Sts. to Mifflin St.; capital stock, $26,000; Pres., John A. Rigg.——Chartered, Federal St. Passenger Ry. Co.; 8th and Federal Sts. to Johnson St.; capital stock, $20,000; Pres., John A. Rigg.

SUDBURY, PA.—Charteded, Selinsgroove & Sudbury St. Electric Ry. Co.; Selinsgroove to Sudbury; capital stock, $100,000; Pres., C. C. Hamilton, Shamokin, Pa.

JERSEY CITY, N. J.—Chartered, United Traction & Electric Co.; capital stock, $8,000,000; incorporators, H. W. Calhoun, New York, N. Y.; H. J. Larkin, Nutley, N.J.

JACKSONVILLE, FLA.—The Jacksonville Street Ry Co. will equip its line for electric propulsion.

CHICAGO, ILL.—Chartered, Chicago, Niles & Norwood Rapid Transit Co.; capital stock, $500,000; incorporators, F. A. Bingham, Robert Ader and J. P. Mars.——Chartered, Chicago & Southwestern Electric Ry Co.; capital stock, $100,000; incorporators, Geo. W. Warr, Fred. S. Collier, A. L. Burkin.

LEAVENWORTH, KAN.—Arrangements are being made to build an electric railway from Ft. Leavenworth to the Soldiers' Home.

WICHITA, KAN.—The Wichita Electric Ry. Co. and the Citizens' Electric Light Co. have been consolidated under the name of the Wichita Ry. & Light Co., with a capital stock of $500,000. Officers were elected as follows: Charles E. Dustin, of Hartford, Conn., Pres.; A. T. Batchelder, Keene, N. H., Vice-Pres.; J. W. O'Neil, of Wichita, Secy. and Gen. Man.; George A. Litchfield, of Keene, N. H., Treas., and Arthur Faulkner, of Wichita, Asst. Treas.

OREGON CITY, ORE.—The Portland General Electric Co. have let contracts for a 3-mile electric railway from Oregon City to the Tualitan River, and surveys are completed for a line from Oregon City to Oswego, Ore., 5 miles.

HORSE AND MOTOR RAILWAYS.

JERSEY CITY, N. J.—Chartered, New England St. Ry. Co.; capital stock, $5,000,000; A. B. Turner, Newton, Mass.; J. B. Dill, East Orange, N. J.

PHILADELPHIA, PA.—Chartered, Baltimore Ave. Ry. Co.; capital stock, $50,000; Pres., Wm. Jenks Fell, 4120 Chester Ave.——Johnston St. Passenger Ry. Co.; Shunk and 28th St. to Johnson St.; Pres., John A. Rigg.

WILKES-BARRE, PA.—Chartered, Wilkes-Barre & North Side Ry. Co.; capital stock, $30,000; Pres., John B. Reynolds, Kingston, Pa.——Chartered, Wilkes-Barre & Plymouth Ry. Co.; capital stock, $30,000; Pres., John B. Reynolds.

PEORIA, ILL.—Chartered, South Peoria St. Ry. Co.; capital stock, $100,000; incorporators, Chas. A. North, Isaac M. Honnbacker, and John W. Colbertson.

HIGHWAYS.

NEW YORK.—The town board of Oyster Bay has called a special meeting to be held Feb. 25 to consider the proposition to macadamize about two miles of the North Hempstead turnpike. If this is done it is claimed that the town of North Hempstead will complete the roadbed of the turnpike to the Oyster Bay town line.

OHIO.—The legislature has passed the Montgomery road bill. This bill provides for assessing one-half the expense upon Hamilton county, and the improvement authorized is estimated as follows: 68,288 sq. yds. of brick or asphalt roadway, 126,729 sq. yds. of macadamized roadway, 60,192 lin. ft. of stone curb, and 133,056 sq. ft. of concrete sidewalks; estimated cost, about $400,000. The legislature is considering a bill providing for another boulevard in this county, which will have a width of 80 ft. and extend from the north of Cincinnati to the county line, a distance of about eight miles; estimated cost, $300,000 to $350,000. About $20,000,000 of property would be benefited.——The commissioners of Cuyahoga county have prepared specifications for improving the Columbus pike, Newburg and Bedford road, and the St. Clair road in East Cleveland township. The plan to be tried upon these roads calls for a telford roadbed on one side and an earth bed on the other. Jay F. Brown, Cleveland, has been appointed engineer to make necessary surveys and to outline the work of the contractors.

IDAHO.—The Workmen state wagon-road bill, referred to in our issue of last week, has been passed by the senate with only one dissenting vote, and it is claimed will receive the governor's approval. The roads provided for are a 40-mile link in the Little Salmon, which will make a connection between north and south Idaho, a branch to Elk City, and a road from Bear Valley, in Boise county, through Custer and Lemhi counties to the Montana line. At present there is no road connecting Lemhi county with the central portion of the state, all travel going out into Montana on the line of the Utah & Northern. The money for building this system of roads is to be raised by an issue of $130,000 of bonds.

WATER-WORKS.

New England.

WEST BRIDGEWATER, MASS.—The selectmen have petitioned for authority to build works.

BRANFORD, CONN.—It is reported that surveys have been made here in the interest of the Syndicate Water Co.

CROMWELL, CONN.—The proposed new works may consist of an extension across the river of the Portland works.

Middle.

BABYLON, N. Y.—It is reported that surveys for the works of the Sumpawams Water Co. will be made by Engr. Oscar Darling, Huntington.

FAIRPORT, N. Y.—A recent fire has brought to mind the estimates for works made some time ago. A well, 1,000,000-gallon pumping plant and stand-pipe were recommended, which, with the distribution system, were estimated to cost $28,000.

FORT EDWARD, N. Y.—The people have voted 236 to 32 for village works, and Engr. S. E. Babcock, Little Falls, has been called in. Small private works are in use.

NASSAU, N. Y.—Works are projected. Geo. H. Lewis, clk. village trustees.

NEW YORK, N. Y.—Bids for $250,000 3% "additional water stock of the city of New York" are wanted until Feb. 27. Theo. W. Myers, Comptroller.

SCHENECTADY, N. Y.—The water commissioners have recommended a new intake, two intake wells and a 10,000,000-gallon pumping plant.

SEA CLIFF, N. Y.—It is reported that the village has contracted with the Sea Cliff Association for water during the entire year, including 25 hydrants. Water has been furnished in the summer heretofore.

MALVERN, PA.—The water company may put in hydrants; it now furnishes water for domestic use only.

ALTOONA, PA.—The water commissioners have awarded the contract for the new Kittaning Point reservoir to the Continental Construction Co., New York.

CAMBRIDGE, MD.—Engr. J. M. Seabury, Philadelphia, has made a proposition to build works on the franchise plan, as also have local parties. Address J. H. Johnson.

FROSTBURG, MD.—It is reported that the town council wishes bids for pumping water from the opposite side of Savage Mt.; estimated cost, $5,250.

Southern.

WHEELING, W. VA.—A bill has been introduced in the legislature authorizing the city to supply water to outside towns, the new works now under construction making this feasible.

WILSON, N. C.—A contract for works is reported as given to a firm in Dayton, O., for $51,270, the supply to be from Toisnot swamp.

NEWMAN, GA.—Address the mayor regarding proposed city works.

MONROE, LA.—It is reported that the Monroe Water-Works Co. will begin the construction of works at once. C. N. Priddy, Gen. Man., Leadville, Colo.

CLARKSVILLE, TENN.—Probably the city will buy the company's works.

HARRIMAN, TENN.—A vote will be taken March 9 on issuing $50,000 of bonds for works; also $45,000 for a sewerage and $15,000 for an electric lighting system.

MORRISTOWN, TENN.—Authority to build city works is being sought.

North Central.

CANTON, O.—New pumping machinery, at an estimated cost of $60,000, is reported as proposed.

CLEVELAND, O.—An extension of the intake tunnel and a new pumping station are proposed. A steel intake, proposed by Mr. Robert Powell, to be laid in a single two-mile section, is again talked of. This intake was described and illustrated in Engineering News of March 19, 1892.

HUBBARD, O.—A petition for the issuance of bonds for works will be presented to the council.

MANSFIELD, O.—Water meters and main extensions are proposed.

LA SALLE, ILL.—A new boiler and new mains are proposed.

ALPENA, MICH.—There is talk of municipal water and lighting plants. The city has the right to buy the present private works in 1894.

TURNER, ILL.—Works are proposed.

WINNETKA and GLENCOE, ILL.—A joint supply is proposed from a tunnel extending into the lake, with a pumping station and tower.

KAUKAUNA, WIS.—Bids for putting in works will be received until March 15; whether for the city or on the franchise plan is not stated. W. F. Goodhue, Milwaukee, has applied for a franchise.

Northwestern.

WASHINGTON, KAN.—Consult. Engr. A. A. Richardson, Lincoln, Neb., informs us that bids for building works will be received until March 6; estimated cost, $30,000. Address city clerk for specifications.

ST. PAUL, MINN.—A contract for 1,000 tons of cast iron pipe has been awarded to Denis Long & Co., Louisville, Ky., the lowest bidders, for $24.37 per ton. The Union Brass & Metal Mfg. Co. have the contract for brass, at $1,200, and Bingham & Taylor, Buffalo, N. Y., for valve and stop cock boxes, at $1,823. Fifty hydrants will be furnished by the Northwestern Wheel & Foundry Co., at $35 and $40 each; the same firm will supply the special castings.

Southwestern.

COLUMBIA, MO.—The Columbia Water & Light Co. has been incorporated; $80,000.

INDEPENDENCE, MO.—Provided the company and city can agree on a new franchise, $50,000 may be expended for mains and other improvements.

ST. LOUIS, MO.—A temporary pumping plant will probably be put in at Chain of Rocks.

GRANGER, TEX.—A petition favoring works is being signed.

DENVER, COLO.—Cy. Atty. Williams has prepared an ordinance providing for an election to decide whether the city will acquire works. The two companies have been carrying on a rate war for nearly a year.

Pacific.

HOQUIAM, WASH.—The town may be bonded $45,000 for works, with a supply from a point on the Hoquiam River about 4½ miles from the city. The present supply is from a small private plant.

LEBANON, ORE.—Works are proposed.

PHOENIX, ARIZ.—The council has granted a franchise for works to John W. Osborne, construction to begin Jan. 1, 1894, and five miles of mains to be laid in 1894. Mr. Osborne, D. A. Abrams and C. D. Baker have since incorporated the Citizens' Water Storage & Supply Co.; $750,000. A company now supplies the city. The new franchise gives the city the option of buying the works at the end of five years. If the option is not exercised, the city may regulate the rates provided the company's profits are not kept below 7% on its investment.

Canada.

LONDON, ONT.—Bids are wanted until Feb. 28 for furnishing and laying cast iron mains, for special castings, brass fittings and lead pipe. John M. Moore, Engr. and Supt.

IRRIGATION.

CALIFORNIA.—A press dispatch states that Minnesota capitalists have obtained from the Hesperia Land & Water Co. an option on the water right and dam site at Victoria Narrows, on the Southern California Ry., about 50 miles north of San Bernardino, and that a dam will be built, 170 ft. high and 75 to 150 ft. long, across the Mojave River.

TUCSON, ARIZ.—A scheme is on foot to irrigate about 8,000 acres north of the city, water to be taken from the Santa Cruz River, about 1½ miles from the city.

NEW COMPANIES.—The Lupton Short Line Ditch & Reservoir Co., Fort Lupton, Colo.; $8,000; T. L. Monson, Secy. Gypsum Ditch Co., Delta, Colo.; $5,000; Herman O. Bear, Henry H. Ingersoll, Lamar Canal Co., Lamar, Colo.; $50,000; T. B. Sweet, H. J. Page; water will be taken from the Arkansas River. East Highlands Water Co., East Highlands, Cal.; $100,000; B. F. Edwards, East Highlands; F. E. Brown, Redlands.

SEWERS.

LENOX, MASS.—At a special town meeting Feb. 13 to consider the subject of sewage disposal, it was voted to purchase land on which to erect a pumping station, and to pump the sewage from the west side of the town into the present outfall sewer on the east side. The pumping station will be constructed as soon as possible. It was also voted to alter, extend and enlarge the existing sewer system of the town.

PLYMOUTH, MASS.—The committee on sewerage, appointed last fall, recommends that the construction of a system be commenced, and that about $15,000 be expended this next summer.

SOUTH HADLEY, MASS.—The adoption of a sewerage system is to be considered at the coming town meeting.

SWAMPSCOTT, MASS.—The question of sewage disposal is being considered preparatory to submitting plans and estimates at the town meeting next month. Rudolph Hering, New York, has presented three plans, the first of which he recommends for adoption provided satisfactory arrangements can be made with the city of Lynn: Connecting with Lynn sewer, estimated cost of construction, $64,764; filtration, $77,705; emptying into the ocean, $101,000.

PROVIDENCE, R. I.—Plans are being prepared for additional sewer extensions.

FAR ROCKAWAY, N. Y.—At the special election Feb. 14, the citizens voted 74 to 70 against the plans adopted by the sewer commission. The plans proposed called for the Powers gravity system, with disposal works, and an appropriation not to exceed $125,000, with an annual maintenance cost of not more than $10,000. About a year ago this system was defeated by a large majority, the opponents desiring the Shone system, which includes pumping works as well as disposal.

JAMAICA, N. Y.—The following board of sewerage commissioners have been appointed: Col. A. A. Degraw, John Adikes, Prof. Emile Vienot, Dr. P. M. Wood and J. T. Watts.

STAMFORD, N. Y.—The contract for a sewerage system has been awarded to Jehiel Vaughn, at $6,128.

SYRACUSE, N. Y.—Plans are being prepared for important sewer extensions.

MERIDIAN, MISS.—We are informed by N. M. Brandon, Cy. Engr., that Samuel M. Gray, Providence, R. I., has been engaged to submit plans and estimates for a sewerage system. The city engineer has already prepared the topographical map, profile and other necessary data. An expenditure of nearly $100,000 is contemplated, and work will be commenced as soon as possible.

BEDFORD CITY, VA.—Work will probably be commenced upon a sewer system this spring. P. M. Cabell, Cy. Engr.

ALLIANCE, O.—A. B. Love and J. C. Devine are members of a committee appointed to investigate the question of a sewerage system. This committee has visited Canton, Massillon and other places.

CLEVELAND, O.—The plans for the Walworth Run sewer have been approved. This sewer will be 13,000 ft. long, and have a diameter of 8.5 to 16.5 ft. It will drain almost the entire west side.

HAMILTON, O.—The city desires authority from the legislature to issue bonds for $100,000 for a sewer system. Plans and specifications have been prepared by the city engineer.

MINERVA, O.—The need of better sewerage is being urged by the local press.

NILES, O.—A sewerage system will probably be constructed in the near future. A. I. Orr, Cy. Clk.

INDIANAPOLIS, IND.—The board of public works will receive bids until March 1 for two local sewers.

WINONA, MINN.—Bids will soon be asked for 5,000 ft. of 12 to 18 in. pipe sewer, average cut 6.5 ft., estimated cost, $5,500. Fred H. Pickles, Cy. Engr.

SIOUX FALLS, S. DAK.—Bids are asked until March 6 for 68,000 lin. ft. of sewers. Roy Williams, Cy. Aud.

SOUTH OMAHA, NEB.—A sewer to cost $140,000 is under consideration.

DENVER, COLO.—Plans and estimates have been prepared for several sewers, including one to cost about $112,000. Work to cost over $400,000 is contemplated.

FRESNO, CAL.—An election will be held March 4 to vote on the issue of bonds for $75,000 for a sewer system.

MENDOCINO CITY, CAL.—The citizens have voted to construct a sewerage system, and the work will be begun as soon as the weather permits.

OAKLAND, CAL.—The city engineer has prepared plans for a sewer to cost about $110,000. A contract has been awarded to John Geary at $11,118.

OREGON CITY, ORE.—We are informed by Sidney Smyth, Cy. Engr., that a sewerage system is under consideration; 1,000 ft. of brick and 15,000 ft. of pipe sewer.

PENDLETON, ORE.—We are informed by J. W. Kimbrell, Cy. Engr., that the city will probably issue bonds for $20,000 for a sewer system to be constructed in the near future.

EVERETT, WASH.—The Everett Sewer Co. has been incorporated to operate sewers in this city; capital, $10,000.

STREETS.

POUGHKEEPSIE, N. Y.—We are informed by W. M. Ketchum, mayor, that the city is planning paving improvements, dependent upon charter amendments now before the legislature.

OLEAN, N. Y.—F. A. Dunham, Plainfield, N. J., has been appointed engineer in charge of improvements in four streets, which are to be paved and sewered. Bids will be received until March 13 for about 23,000 sq. yds. of brick paving.

ATLANTIC CITY, N. J.—The city council desires authority from the legislature to issue bonds for paving and street improvements.

BEDFORD CITY, VA.—It is reported that the city will spend $25,000 in street improvements. We are informed by P. M. Cabell, Cy. Engr., that no definite plans have yet been decided upon, but that work will probably be commenced in the spring.

ATLANTA, GA.—Additional asphalt paving has been ordered for Peachtree St., to cost about $52,000. The contracts will be let as soon as possible.

COLUMBUS, GA.—Bids are asked until April 5 for about 22,000 sq. yds. of telford or granite block paving. M. M. Moore, Clk. Council.

JACKSONVILLE, FLA.—The city council has voted to pave Bay St. with brick.

NEW ORLEANS, LA.—The city is contemplating the paving of Decatur St., 30,000 lin. ft., and other streets with square block stone. A large number of streets are being paved with gravel. L. W. Brown, Cy. Engr.

CLEVELAND, O.—In addition to the work noted last week, the director of public works will receive bids as follows: March 1, grading, draining, constructing culverts, etc., in 14 streets; March 15, paving 3 with Medina blockstone, 2 with blockstone or granite, 3 with Medina common stone, 4 with Trinidad asphalt, and 5 with paving brick.

NILES, O.—The principal streets of the village are to be paved.

SOUTH BEND, IND.—We are informed by Wm. M. Whitten, Cy. Engr., that the council has ordered about 43,000 sq. yds. of brick paving for the coming season.

GRAND RAPIDS, MICH.—The city engineer has reported estimates for paving in ten streets, the work to cost nearly $100,000.

SAGINAW, MICH.—Improvements have been ordered to cost $200,000.

STREATOR, ILL.—Assessments have been prepared for brick paving, to cost nearly $150,000. As noted in our issue of Jan. 26 bids for the work will be received April 3 and July 3.

WINONA, MINN.—Fred. H. Pickles, Cy. Engr., informs us that bids will be opened March 6 for 72,000 sq. yds. of paving with vitrified brick, 26,000 lin. ft. of limestone curbing, and 29,000 cu. yds. of extra grading; estimated cost, $140,000.

JOPLIN, MO.—The citizens will vote on the issue of bonds for $10,000 for the improving of Broadway.

OREGON CITY, ORE.—We are informed by Sidney Smyth, Cy. Engr., that the city proposes to pave about three-quarters of a mile with vitrified brick, and one mile with gravel.

GUELPH, ONT.—The city council has voted to engage an engineer to supervise proposed street work, which will be done by day labor.

ELECTRICAL.

WALDOBORO, ME.—The Winslow Illuminating & Power Co., composed of Geo. Bliss, E. O. Clark and others, seeks incorporation for the purpose of furnishing electric light and power, building mills, etc.

MONROE, N. C.—The mayor will receive bids until Feb. 27 for an electric light plant to run 24 arc lights of 2,000 c. p., and 300 incandescent lights.

MADISON, GA.—It is reported that the cost of running the municipal electric light plant is $325 per month. The city has 50 arc and 25 incandescent lights, and receives $125 per month for incandescent lights furnished to private citizens at $1 per light per month.

CENTRALIA, ILL.—Prominent citizens of this place, Sandoval and Odin are preparing to organize a company to build and operate an electric light and railway plant. S. N. Pierce is interested.

IDA GROVE, IA.—An electric light franchise for 15 years has been granted to J. W. Reed and others.

MARSHALL, MO.—At the special election Feb. 14 the proposition to light the city by electricity was carried by a large majority. The contract will be let, and work on the plant will be commenced as soon as the weather permits. The franchise has been granted to Wardell McCully, as stated in our issue of Feb. 2.

DE WITT, ARK.—The city desires bids for an electric plant, the contractor to accept 15-yr. 6% gold bonds, interest guaranteed, in part payment. Address, T. H. Leslie.

POMONA, CAL.—The board of trustees has passed the Burns electric light franchise, the work to be commenced within 90 days and a plant of at least 75 E. HP. to be completed within one year.

SAN FRANCISCO, CAL.—Considerable complaint is made because of the price and quality of the electric light furnished the city. The city hall commissioners have ordered that plans and specifications be prepared for erecting a dynamo in the basement of the new city hall. It is reported that a franchise will soon be granted to one or more new companies.

LEAMINGTON, ONT.—Bids are asked until March 1 for an electric light plant to be operated in connection with the water-works system. B. E. Brush, Secy. of Com.

LONDON, ONT.—The city council has voted to petition the legislature for authority to operate a municipal electric light plant for both public and private purposes.

CONTRACT PRICES.

PIPE.—St. Paul, Minn.—The contract for about 1,000 tons of pipe has been awarded to Dennis Long & Co., Louisville, Ky., at $24.37 per ton.

CEDAR AND TAMARACK BLOCKS.—Hamilton, Ont. The city council has awarded a contract for cedar and tamarack blocks to D. D. Van Vlack, Toronto, at 37 cts. per sq. yd.

BLOCK STONE PAVING.—New Orleans, La.—We are informed by L. W. Brown, Cy. Engr., that contracts have recently been awarded for paving about 3,000 lin. ft. with square block stone, at $5.25 per sq. yd. The high price is due in large measure to the freight charges on the stone.

SEWERS.—Boston, Mass.—Bids were opened Feb. 11 for section 37 of the Metropolitan main sewer, in East Boston, the average cut being 28.6 ft. The total bids were as follows: 1, Everson & Liddle, Providence, R. I., $89,800; 2, National Construction Co., Boston, $72,443; 3, Malone & Talient, Everett, $71,264; 4, H. P. Nawn, Boston, $70,500; 5, Jones & Meehan, Jamaica Plain, $61,055; 6, Metropolitan Construction Co., Boston, $53,697; 7, John Sheehan, Lynn, $45,961.

The work is as follows: A, 400 lin. ft. of earth excavation and refill for 40 x 45-in. sewer, per lin. ft.; B, 4,440 lin. ft., for 36 x 41-in. sewer, per lin. ft.; C, 1,000 cu. yds. brick masonry, American, per cu. yd.; D, 300 cu. yds., Portland, per cu. yd.; E, 150 cu. yds. concrete masonry, American, per cu. yd.; F, 100 cu. yds., Portland, per cu. yd.; G, 10,000 ft. B. M. spruce lumber, in place, per M. ft., B. M.

	A.	B.	C.	D.	E.	F.	G.
1.	$14.50	$14.50	$12.00	$16.00	$6.00	$7.50	$30
2.	11.84	10.87	12.53	14.33	5.50	7.40	34
3.	10.60	10.20	14.00	16.00	7.00	8.50	40
4.	10.00	10.00	15.00	16.00	5.00	7.00	25
5.	8.45	8.45	13.00	15.50	6.00	8.00	30
6.	7.25	7.25	12.15	13.95	5.25	7.00	35
7.	6.00	5.40	12.90	15.00	5.50	6.50	35

MISCELLANEOUS.

HARBOR IMPROVEMENTS.—Philadelphia, Pa.—Secretary Elkins has decided the controversy over the award of the contract for dredging the Delaware River and making a safe approach to Philadelphia harbor by rejecting all the bids. The controversy was referred to in our last issue and the bids received for the work were published Feb. 9. The work will be re-advertised.

GARBAGE DISPOSAL.—Indianapolis, Ind.—The board of public works will receive bids until March 13 for a plant for the disposal of garbage and nightsoil by cremation or other process.

MILITARY POST.—Essex Junction, Vt.—Plans for a military post near this place have been approved, and the work will soon be advertised. The plans include sewers, roads and water-works.

COURTHOUSE AND JAIL.—Huntersville, W. Va.—Bids are asked until March 7 for the construction of a courthouse and jail at Marlinton, W. Va.; bids to be received for one building or for two. S. L. Brown, Clk., Co. Court.

GAS COMPANIES.—Hudson River Gas Light Co., Bayonne, N. J.; $100,000; R. A. Britton, J. Creight, T. J. Burnier. Lake Superior Fuel Gas Co., Chicago, Ill.; $3,000,000; Faye Walker, Robt. H. Harris, L. B. Langworthy. Thermogen Fuel & Light Co., Jersey City, N. J.; $250,000; F. R. Fennessy, New York, and J. Plenty, Jersey City. Salt Lake & Ogden Gas & Electric Light Co., Jersey City, N. J.; $1,500,000; C. H. Ludington, Jr., and E. C. Henderson, New York, and W. Talcott, Paterson.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have orders for 15 ten-wheel engines, 5 eight-wheel engines, 1 compound eight-wheel engine and 5 switching engines for the Central of New Jersey, and 2 switching engines for the Long Island. The Manchester Locomotive Works, Manchester, N. H., are building 12 mogul engines, 12 eight-wheel engines and 6 four-wheel switching engines for the Boston & Maine. The Brooks Locomotive Works, Durkirk, N. Y., have an order for 40 engines for the Great Northern. The Dunkirk Engineering Co., Dunkirk, N. Y., has built a heavy logging engine for the Douglass Lumber Co., Cleveland, Va. The Intercolonial Ry. will sell 9 standard gage express and 2 engines of 42 ins. gage; Gen. W. D. Pottinger, Moncton, N. B.

CARS.—The Missouri Car & Foundry Co., St. Louis, Mo., has an order for 300 freight cars for the Pennsylvania. The Haskel & Barker Car Co., Michigan City, Ind., is building 750 furniture and 250 platform cars for the Great Northern. The Jackson & Sharp Co., Wilmington, Del., is building 20 passenger cars for the Long Island. The Ohio Falls Car Co., Jeffersonville, Ind., is building 2 passenger cars for the Louisville, New Albany & Chicago. The Wilkes-Barre & Hudson River Construction Co. has issued specifications for 1,200 hopper coal cars for the New York, Susquehanna & Western. The Muskegon Car Co.'s works, at Muskegon, Mich., which has been idle for nearly two years, have been secured by Hovey & McCracken, of Muskegon. The works have a capacity of ten cars a day.

INDIANA CAR & FOUNDRY CO.—At the annual meeting on Feb. 7 the following officers were elected: Pres., Major Collins; Vice-Pres., Archer Brown; Sec. and Treas., Emil Pollak; Gen. Man., J. C. Fortiner. The financial office of the company is in Cincinnati, O. Large contracts for cars have been taken, amounting to over $1,000,000. Among these are coal cars for the Pennsylvania R. R., World's Columbian Exposition passenger cars for the Illinois Central R. R., and improved cattle cars for the Hicks Stock Car Co. The works now give employment to about 500 men, which number will be increased to 800.

CATTLE GUARDS.—The Kalamazoo Railroad Velocipede & Car Co., of Kalamazoo, Mich., reports that it has sold 1,600 sets of its new cattle guard since it was first placed on the market, in June, 1892. No. 13 sheet steel is now used, instead of No. 14, and the result is a stiffer and more durable guard. The Missouri, Kansas & Texas Ry. has 700 sets of these guards in use, and they report that it is the only cattle guard yet tried on their line that will effectually turn stock, with the added advantage that it is impossible for cattle to become entangled or fastened when they are forced upon the guards.

STREET ROLLERS.—The Board of Park Commissioners of Toledo, O., has adopted Pope's improved reversible street rollers to build the driveways in the city parks, and the first order for a six-ton horse roller has been issued; the price is $630. The following street contractors of Chicago have adopted Pope's reversible street rollers for all sub-grade rolling on new street construction, in place of 10-ton steam rollers, formerly used by them, being found, as it is claimed, more efficient in handling and 90% less cost. This change has been approved by George W. Dorr, Chief Engineer Bureau of Streets, and twelve blocks of streets on Wabash Ave. were built with this roller last season, besides many others in the western portion of the city: Egelston, Mallette & Brownell, Garden City Post & Paving Co., Kimbell, Cobb & Co., R. F. Conway, Sackley & Peterson, and Talbot Paving Co.

SOLID EMERY WHEELS.—The Tanite Co., Stroudsburg, P., has published a report of Messrs. Coleman Sellers, J. E. Denton and A. F. Wolff upon the comparative value of 15 varieties of solid emery wheels. Of these wheels 6 were condemned as unsafe, and 11, including the 6, were very slow cutters. Of the 4 rapid cutters left, one wore out too rapidly and another worked at greater cost. The Tanite wheel was one of the two left and thus demonstrated its superiority to 13 out of 14 wheels tested. Not a single Tanite wheel burst, though subjected to twice the speed of any other wheel under heavy pressure; it cuts better on the average in the last than in the first cut, and does its work at a low cost, says the report.

THE J. A. FAY & EGAN CO., Cincinnati, O., has been formed by the consolidation of J. A. Fay & Co., and the Egan Co., large manufacturers of wood-working machinery. Pres., T. P. Egan; Vice-Pres., F. Danner; Secy., E. Rutheren; Supt., S. P. Egan.

BOOTH, GARRETT & BLAIR, Philadelphia, Pa., who make a specialty of testing, inspecting and chemical analyses, have issued a set of tables of weight and pressures of pipe, etc.

QUEEN & CO., Philadelphia, Pa., have purchased from Mr. John T. Warden, of Philadelphia, the sole right to manufacture an sell his automatic drawing table. It is said to have come into favorable notice and to be used in many of the largest drafting rooms in the country. This table is adjustable for use either flat, or slanting from either side, and it is adjustable for height as well as for angle. The straight edge which takes the place of the T-square always moves parallel from a lazy tongs motion by which strings are dispensed with.

THE MOZIER SAFETY SIGNAL CO., Galion, O., has been awarded the contract for equipping the Cleveland, Akron & Columbus R. R. with its signals between Akron Junction and Warwick, O. Pres., A. M. Mozier; Secy., A. F. Lowe; Gen. Agent, F. M. Canfield, Sr. The office is at Cleveland, O., and the works are at Galion, O.

CURRENT PRICE LIST.

RAILS.—New York: $29 at eastern mills and at tidewater; girder rails, $35 to $36; old rails, $17 for iron, and $14 to $15 for steel. Pittsburg: $29; old rails, $20 for iron and $15 to $15.50 for steel. Chicago: to $32 for standard sections; old rails, $18.50 for iron and $11.50 to $15 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.55 to 1.6 cts.; spikes, 1.87 to 2 cts.; track bolts, 2.4 to 2.45 cts. with square and 2.55 to 2.6 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.65 to 1.75 cts.; for iron and steel; spikes, 2 to 2.05 cts. at mill; track bolts, 2.6 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 55% and 10%, and 47½% and 10% on black and galvanized butt welded; 65% and 10%, and 55% and 10%, on black and galvanized lap welded. Casing, 57½%. The "Iron Age" says the trade is very much demoralized, and quotations are largely according to size of order, delivery, etc.

FOUNDRY PIG IRON.—New York: $13.25 to $15. Pittsburg: $12.75 to $14. Chicago: $12.50 to $14.

LEAD.—New York: 3.95 to 4 cts.; Chicago: 3.65 to 3.7 cts.; St. Louis: 3.7 cts.

STRUCTURAL MATERIAL.—New York: beams, 2 to 2.35 cts. for large lots, and 2.25 to 2.75 cts. for small lots; channels, 2.1 to 2.2 cts.; angles, 1.85 to 2 cts.; tees, 2.1 to 2.3 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.85 to 2 cts. for tank, 2.1 to 2.25 cts. for shell, 2.4 to 2.5 cts. for flange, 2.6 to 2.8 cts. for firebox. Pittsburg: beams, 1.8 to 1.9 cts.; channels, 1.8 to 1.9 cts.; angles, 1.7 to 1.75 cts.; tees, 2 to 2.1 cts.; Z bars, 1.9 cts.; universal mill plates, 1.7 to 1.75 cts.; sheared steel bridge plates, 2.1 to 2.25 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.7 to 1.75 cts. for tank, 1.95 to 2 cts. for shell, 2.05 to 2.1 cts. for flange, 3.4 to 3.5 cts. for firebox, 1.9 to 2 cts. for bridge. Chicago: beams, 2 to 2.1 cts.; channels, 2.27 to 2.5 cts.; angles, 1.85 to 1.95 cts.; tees, 2.2 to 2.3 cts.; sheared plates, 1.9 to 1.95 cts.; universal plates, 1.85 to 1.95 cts.; steel plates (at mill), 1.9 to 2 cts. for tank, 2.12 to 2.25 cts. for shell, 2.27 to 2.3 cts. for flange, 2.7 to 2.8 cts. for firebox.

LOGAN, UTAH, WATER-WORKS.

Sealed proposals will be received by the undersigned until 2 p. m., March 15, 1893, for the manufacture and delivery of part of the materials required for a gravity system of water-works for Logan, Utah.

The following amounts are approximately correct, viz.:

2,140	lin.	ft.	12-in. pipe.
8,000	"	"	10-in. "
24	"	"	8-in. "
751	"	"	6-in. "

7½ tons specials, 15 hydrants, 1 pressure regulator, 17 valves, lead, oakum, tools. Specifications are prepared for both cast iron and Kalamein piping, a copy of which will be mailed to any pipe manufacturer upon application to the Recorder.

Proposals are to be made on the form accompanying the specifications, are to be marked "Proposal for Water-Works Materials," and sent to the Recorder of Logan City, Utah.

The right is reserved to reject any or all bids.

SAMUEL FORTIER,
Ogden, Utah, Consulting Engineer.
JAMES ADAMS,
Logan, Utah, Chairman W. W. Comm.
ADOLPH ANDERSON, City Recorder.

8-2t

NOTICE TO PAVING CONTRACTORS.

Sealed proposals will be received by the Board of Commissioners for the Laurens street improvement of the village of Olean, N. Y., at their offices, room 12, City Building, until 2 o'clock p. m., on Monday, the 13th day of March, 1893, for the paving with vitrified paving brick of Laurens street between Union and Fourth streets in said village.

The approximate amount of pavement to be laid is 4,900 sq. yds. New curbstone and drain tile will also be furnished and laid where necessary.

Plans and specifications may be examined and further information obtained on and after March 1st, 1893, at the office of the Engineer, Room 12, City Building, Olean, N. Y. F. A. DUNHAM, Eng. in Charge.

J. K. VAN KAMPEN,
E. E. HOMER,
GEO. T. KEITH,
8-3t Board of Commissioners.

NOTICE TO PAVING CONTRACTORS.

Sealed proposals will be received by the Board of Commissioners for the Barry street improvement of the village of Olean, N. Y., at their office, Room 12, City Building, until 2 o'clock p. m., on Monday, the 13th day of March, 1893, for the paving with vitrified paving brick of Barry street, between Green street and the W. N. Y. & P. R. R., in said village.

The approximate amount of pavement to be laid is 10,600 sq. yds. New curbstone and drain tile will also be furnished and laid where necessary.

Plans and specifications may be examined and further information obtained on and after March 1st, 1893, at the office of the Engineer, Room 12, City Building, Olean, N. Y. F. A. DUNHAM, Eng. in Charge.

J. K. VAN CAMPEN,
A. T. EATON,
A. E. SMITH,
8-3t Board of Commissioners.

NOTICE TO PAVING CONTRACTORS.

Sealed proposals will be received by the Board of Commissioners for the Second street improvement, of the village of Olean, N. Y., at their office, Room 12, City Building, until 2 o'clock p. m., on Monday, the 13th day of March, 1893, for the paving with vitrified paving brick of Second street, between State street and Henley street.

The approximate amount of pavement to be laid is 1,787 sq. yds. New curbstone and drain tile will also be furnished and laid where necessary.

Plans and specifications may be examined and further information obtained on and after March 1st, 1893, at the office of the Engineer, Room 12, City Building, Olean, N. Y. F. A. DUNHAM, Eng. in Charge.

J. K. VAN CAMPEN,
W. R. PAGE,
C. T. NICKUM,
8-3t Board of Commissioners.

NOTICE TO PAVING CONTRACTORS.

Sealed proposals will be received by the Board of Commissioners for the East State street improvement of the village of Olean, N. Y., at their office, Room 12, City Building, until 2 o'clock p. m., on Monday, the 13th day of March, 1893, for the paving with vitrified paving brick East State street, between Union street and the east bounds of the corporation in said village.

The approximate amount of pavement to be laid is 6,160 sq. yds. New curbstone and drain tile will also be furnished and laid where necessary.

Plans and specifications may be examined and further information obtained on and after March 1st, 1893, at the office of the Engineer, Room 12, City Building, Olean, N. Y. F. A. DUNHAM, Eng. in Charge.

J. K. VAN CAMPEN,
J. V. D. COON,
J. L. BAXTER,
8-3t Board of Commissioners.